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1923

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ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND ALEX. RICHARDSON.

OFFICES FOR ADVERTISEMENTS AND PUBLICATION, 35 & 36, BEDFORD STREET, STRAND, LONDON, W.C.2.

VOL. CXVI.—No. 3002.] *LONDON: FRIDAY, JULY 13, 1923.* [*Registered at the General Post Office as a Newspaper.*] [PRICE ... 1s. BY FOREIGN POST 1s. 3½d.

Aveling & Porter, Ltd.,
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A. G. Mumford, Ltd.,
CULVER STREET WORKS, COLCHESTER.
ON ADMIRALTY AND WAR OFFICE LISTS.
ENGINES for Torpedo Boats, Yachts, Launches.
BOILER FEED PUMPS.
See advertisement pages 24 and 25.
PATENT WATER-TUBE BOILERS.
AUTOMATIC FEED REGULATORS.
And Auxiliary Machinery as supplied to the Admiralty. 2179

Dredging Plant
OF ALL DESCRIPTIONS.
FLOATING CRANES. COAL BUNKERING VESSELS.
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Agents: MARINE WORKS, LTD., FRIARS HOUSE, 39-41, NEW BROAD ST., LONDON, E.C. 2.
See half-page Advert. last week and next week. 1332

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Thos. Piggott & Co., Limited,
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See Advertisement last week, page 88.

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PATENT BOILERS *See Page 76.* 1203
Sole Makers: SPENCER-BONECOURT, LTD.,
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Tank Locomotives.
Specification and Workmanship equal to Main Line Locomotives.
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Cochran Boilers.
MULTITUBULAR AND CROSS-TUBE TYPES.
See page 17. 1134

E. J. Davis, M.I.Mech.E.,
Gas Engines Inspected, Tested and Reported upon. Over 25 years' experience. Tel.: 736 and 737 Stratford. Wire: "Rapidising, London."—Great Eastern Road, Stratford, E.15. 1794

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Invincible Gauge Glasses.
BUTTERWORTH BROS., Ltd.,
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in the
SALE AND VALUATION
of 1834
PLANT AND MACHINERY
and
ENGINEERING WORKS.
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Tubes and Fittings.
Sole Licensees in Great Britain for the manufacture of "Armco" Rust and Corrosion Resisting Iron Tubes. 817
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HEAD OFFICE: 24, Robertson Street, Glasgow.
See Advertisement, page 73, July 6.

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PASSENGER AND CARGO STEAMERS,
SHALLOW DRAFT VESSELS. 1552

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Worm Wheels cut up to 12 ft. diam.
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PORTSMOUTH.
SHIP & LAUNCH BUILDERS, Od 3551
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The Strongest Chain in the World.
Sole Manufacturers: WELDLESS CHAINS, LTD., 50, Wellington Street, GLASGOW. 898

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Systems
PRESSURE, AIR, STEAM
For Boilers of all types.
KERMODES LIMITED,
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Naval Outfits a Speciality,
also for Merchant Ships, for Factories, Locomotives, and Industrial Process Furnaces of all kinds.
Supplied to the British and other Governments.
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Locomotives Tank Engines
designed and constructed by
MANNING, WARDLE AND COMPANY, LIMITED,
Boyne Engine Works, Leeds. Od. 2487
See their Illus. Advertisement, page 93, last week.
RAILWAY AND TRAMWAY ROLLING STOCK.
Hurst, Nelson & Co., Ltd.
THE GLASGOW ROLLING STOCK AND PLANT WORKS,
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(ESTABLISHED 1864.)
BUILDERS of RAILWAY CARRIAGES & WAGONS
MAKERS of WHEELS and AXLES of all kinds.
RAILWAY WAGONS FOR HIRE.
Chief Works and Offices:
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London Office: Od 3353
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Henry Butcher & Co.,
AUCTIONEERS, VALUERS AND SURVEYORS
for
ENGINEERING AND ALLIED TRADES
and
INDUSTRIAL PROPERTIES. 9666
63 and 64, CHANCERY LANE, LONDON, W.C.2.

Rosser and Russell, Ltd.,
MECHANICAL ENGINEERS.
QUEEN'S WHARF, HAMMERSMITH, W.
Undertake SPECIAL MACHINE WORK of any description.
WELL EQUIPPED SHOP.
LATHE WORK up to 10 ft. diameter.
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for all Trades,
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Eccles, Manchester.
Tel.: 884 Eccles.

Power and Speed of Vessels.
—Practical Course of Instruction by Correspondence.—Address, for particulars and terms, 1463, Offices of ENGINEERING.

John Bellamy, Limited,
MILLWALL, LONDON, E. 1216
GENERAL CONSTRUCTIONAL ENGINEERS,
Boilers, Tanks, & Mooring Buoys
STILLS, PETROL TANKS, AIR RECEIVERS, STEEL CHIMNEYS, RIVETED STEAM AND VENTILATING PIPES, HOPPERS, SPECIAL WORK, REPAIRS OF ALL KINDS.

IRON & STEEL
Tubes AND Fittings
AND
Steel Plates.

STEWARTS AND LLOYDS, Ltd.
GLASGOW - BIRMINGHAM - LONDON.
See Advertisement, page 55. 1111

Peter Brotherhood Ltd.,
PETERBOROUGH.
STEAM ENGINES AND TURBINES.
GAS AND OIL ENGINES.
AIR COMPRESSORS.
REFRIGERATING PLANT. 1475
See Advertisement, page 53, July 6.

Gearing for Power Transmission.
Including Machine Moulded GEAR WHEELS up to 10 feet dia.;
FLY WHEELS (rope or spur drive) up to 28 feet dia.;
IRON CASTINGS up to 15 tons each, in Loam, Dry or Green Sand;
ENGINES: "Uniflow," "Corliss" or Drop Valve.
BREAKDOWN Repairs a speciality.
CLAYTON, GOODFELLOW & CO., LTD.,
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The Glasgow Railway Engineering Company,
GOVAN, GLASGOW. LTD.,
London Office—12, Victoria Street, S.W.
MANUFACTURERS OF
RAILWAY CARRIAGE, WAGON & TRAMWAY WHEELS & AXLES.
CARRIAGE & WAGON IRONWORK, also CAST-STEEL AXLE BOXES. 1234

One Responsible Engineer
REQUIRED in each works as Agent for our Course of Tuition in Automobile Engineering.
SOUTHERN ENGINEERING INSTITUTE,
Newdigate, Surrey. A 752

Patents DESIGNS AND TRADE MARKS IN ALL COUNTRIES.
E. P. Alexander & Son,
CHARTERED PATENT AGENTS,
306, HIGH HOLBORN, LONDON, W.C.
(Established 1874.)
Telephone: Central 7434. Od 585

'Phone—Holb. 541. Tele.—Andrubo, Holb., London.
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CHARTERED PATENT AGENTS, 1202
20, Southampton Buildings, London, W.C. 2.

Cement.—Maxted & Knott,
LTD., Consulting Cement Engineers, ADVISE GENERALLY on proposed Cement Schemes FOR ENGLAND AND ABROAD. ADVICE ONLY. Highest References. Established 1890.
Address, BURNETT AVENUE, HULL.
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SPECIAL MACHINERY, try—
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Albion Ironworks,
Bridge Road West, Battersea, S.W. 11.
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Carels Diesel & Steam Engines. 1120
CARELS DIESEL & STEAM ENGINES (LONDON), LTD., Carlton House, Regent Street, London, S.W. 1.
Telephone: Regent 3484.

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FEED WATER HEATERS, CALORIFIERS, EVAPORATORS, CONDENSERS, AIR HEATERS, } ROW'S PATENTS.
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SYPHONIA STEAM TRAPS, REDUCING VALVES
High-class GUNMETAL STEAM FITTINGS.
WATER SOFTENING and FILTERING. 3793

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LAND AND MARINE
YARROW BOILERS.
1553

Matthew Paul & Co., Ltd.,
LEVENFORD WORKS, Dumbarton. 1433
See Full Page Advt., page 50, June 22.

Forgings.
Walter Somers, Limited,
HALESOWEN. 7116

Taylor & Challen Presses
For Production of SHEET METAL WORK, COINAGE, CARTRIDGES AND GUNPOWDER.
Foundry, Works, and Showrooms: BIRMINGHAM.
See advert., page 57, June 22. 8195

Head, Wrightson & Co.,
LIMITED.
See Advertisement page 58. 2402

Railway Switches and Crossings.
T. SUMMERSON & SONS, LIMITED,
DARLINGTON. 1312

MACHINE-CUT
D.B.S. GEARS
of every description. 1440
DAVID BROWN & SONS (Hudd.) LTD.,
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Electric Cranes.
Traversers.
Transporters.
Lifts.
S. H. HEYWOOD Co., LTD.,
Reddish. 1357

Centrifugals.
Pott, Cassels & Williamson,
MOTHERWELL, SCOTLAND. 969
See half-page Advertisement, page 67, July 6.

The Manchester Steam Users' ASSOCIATION.

For the prevention of Steam Boiler Explosions and for the attainment of Economy in the Application of Steam. 9, MOUNT STREET, MANCHESTER.
Chief Engineer: C. E. STROMEYER, M.I.C.E.
Founded 1854 by Sir WILLIAM FAIRBAIRN.
Certificates of Safety issued under the Factory and Workshops Act, 1901. Compensation for Damages and Liabilities paid in case of Explosions. Engines and Boilers inspected during construction. 1311

University of Liverpool.

Session 1923-1924.
FACULTY OF ENGINEERING.
Dean: Prof. T. B. ABELL, O.B.E., M.Eng., R.C.N.C., Ret., M.Inst.N.A.
Prospectus and full particulars of the following may be obtained on application to the REGISTRAR:—Engineering, Thermodynamics of Heat Engines, Strength of Materials, Electrical Engineering, Civil Engineering, Naval Architecture, Metallurgy, Geology, Marine Engineering, Design and Drawing, Refrigeration, Mathematics, Physics, Chemistry. A 126

Finsbury Technical College,

LEONARD STREET, CITY ROAD, E.C. 2.

CIVIL AND MECHANICAL ENGINEERING.
Professor H. P. PHILPOT, A.M.Inst.C.E.
ELECTRICAL ENGINEERING.
Professor W. H. ECCLES, DSc., F.R.S.
CHEMISTRY.
Professor A. G. HALE, F.I.C.
The College provides practical scientific training for students who desire to become Civil, Mechanical or Electrical Engineers or Chemists.
Candidates are required to pass an Entrance Examination in Mathematics and English, but the Matriculation Certificate of any British University, and certain other qualifications, are accepted in lieu of it. The next Entrance Examination will be held on Tuesday, 18th September. Applications for admission should be forwarded to the College on forms to be obtained from the REGISTRAR. The Programme of the College may be had on application. B 47

University College of SWANSEA.

(A Constituent College of the University of Wales).

APPLIED SCIENCE DEPARTMENTS.

ENGINEERING.
Professor—FREDERIC BACON, M.A. (Cantab.), A.M.Inst.C.E., M.I.Mech.E., M.I.E.E.
Lecturer in Electrical Engineering—R. G. ISAACS, M.Sc. (Bristol), B.Sc. (Lond.), A.M.I.E.E.
Lecturer in Civil Engineering—H. H. BURNESS, M.C., B.Sc. (St. Andrew's), A.M.Inst.C.E., A.M.I.Mech.E.
Assistant Lecturer—J. SELWYN CASWELL.

METALLURGY.
Professor—C. A. EDWARDS, D.Sc. (Manchester).
Lecturer—H. I. OOE, M.Sc. (Wales and Birmingham).
Assistant Lecturers—A. L. NORBURY, M.Sc. (Manchester), L. B. PFEIL, B.Sc. (Lond.), A.R.S.M.
The College offers a number of exceptional advantages to Students who aim at entering upon professional careers in Engineering or in Metallurgy. It is situated in the heart of an industrial area, which includes a large number of works of very varied character, and presents an unrivalled variety of metallurgical practice. The manufacturers of the district, who contribute largely to the support of the College, give the Staff and students of the Applied Science Departments every access to the Works, and the Managers, Engineers, and Technical Officials co-operate with the Staff of the College in making visits to Works of practical educational value to the students.
Courses of study are provided (1) for the B.Sc. Degree of the University of Wales in (*a*) Civil Engineering; (*b*) Mechanical Engineering; (*c*) Electrical Engineering; (*d*) Metallurgy, and (2) for Diplomas of the College in (*a*) Civil Engineering; (*b*) Mechanical Engineering; (*c*) Electrical Engineering, (*d*) Metallurgy.
Persons who are not desirous of studying for Degrees or Diplomas may attend selected College Classes, provided they satisfy the authorities of the College that they are qualified to benefit by such classes.
Entrance Scholarships will be offered for competition in September, 1923.
Particulars concerning admission to the College, and of the Entrance Scholarships, may be obtained from the undersigned.

EDWIN DREW,
Registrar.

University College,
Singleton Park,
Swansea. B 45

Correspondence Courses for

Inst. Civil Engrs., Inst. Mech. E., London Univ. (Matric., Inter., B.Sc.), and All ENGINEERING EXAMINATIONS personally conducted by Mr. TREVOR W. PHILLIPS, B.Sc. (Honours), Assoc. M.Inst.C.E., M.E.S.I., F.R.S.A., &c. Also Day Tuition in Office. Excellent results at all Exams. Courses may commence at any time, and all Students receive individual tuition.—For full particulars apply to 8/11, TRAFFORD CHAMBERS, 55, SOUTH JOHN STREET, LIVERPOOL. 1205

Engineering Salesmanship

and SALES MANAGEMENT.—Write for brochure describing our special Course of training for posts of unlimited scope in this lucrative field.—DIRECTOR, Institute of Engineering Salesmanship, 333, Oxford Road, Manchester. 1567

TENDERS.

The Director-General,

INDIA STORE DEPARTMENT,
Branch No. 16, Belvedere Road, Lambeth, S.E. 1, requires:—
WELDLESS STEEL CHAIN.
STEEL TUBING, LAP WELDED OR SOLID DRAWN.
VACUUM BRAKE GEAR.
Tenders due on the 2nd August, 1923.
Tender forms obtainable from above. B 54

GREAT SOUTHERN AND WESTERN RAILWAY COMPANY.

The Directors are prepared to receive

Tenders for the Supply and

ERECTION of about 101 tons of STEEL WORK in five short span bridges; and the SUPPLY and DELIVERY only of about 50 tons of STEEL-WORK in seven short span bridges.
Specifications and drawings can be obtained from Mr. J. F. SIDES, M.Inst.C.E., Chief Engineer, Great Southern and Western Railway, Inchicore, Dublin, on payment of £1 1s. 0d., which will not be returned.
The Directors do not bind themselves to accept the lowest, or any Tender.
Tenders must be delivered on or before 28th July, 1923, to the undersigned.

ROBERT CRAWFORD,
Secretary,
Kingsbridge Terminus, B 83
Dublin.

COUNTY BOROUGH OF WARRINGTON.

WATERWORKS DEPARTMENT.

The Water Committee is prepared to consider

Tenders for the Provision and

ERECTION of THREE ELECTRICALLY-DRIVEN CENTRIFUGAL PUMPS at one of their Pumping Stations.
Two of the pumps to be placed in a well and to have vertical drive, the third Pump to be High Lift and driven horizontally.
Tenders to be sent in not later than 11th August, 1923.
Manufacturers of similar plant to the above may obtain further particulars from the undersigned, on payment of a fee of £1 1s., returnable only if a *bona-fide* Tender is submitted.

JAMES GRAY,
Waterworks Engineer.

Municipal Offices,
Warrington.
4th July, 1923. B 44

LONDON AND NORTH EASTERN RAILWAY.

The Directors are prepared to receive

Tenders for the Construction

of a BRIDGE near Hart Station, carrying the new East Coast Road from Easington to West Hartlepool over the Ferryhill and East Hartlepool Branch.
The work consists of Excavation, Concrete Work, Brickwork, 218 tons of Steelwork in Main Plate Girders and Trough Decking.
Plans and Specifications may be seen and detailed quantities and Form of Tender obtained on personal application at the Office of Mr. C. F. BENGOUGH, the Company's Chief Engineer for the North Eastern Area, at York, on and after Wednesday, July 11th, 1923.
Sealed Tenders, marked "Bridge near Hart Station," must be sent to the Company's Secretary at Marylebone Station, London, N.W. 1, not later than NINE a.m. on Monday, the 23rd July.
The Directors do not bind themselves to accept the lowest or any Tender.

JAMES McLAREN,
G. F. THURSTON,
Joint Secretaries.

Secretary's Office,
Marylebone Station,
London, N.W. 1.
6th July, 1923. B 46

THE BENGAL AND NORTH WESTERN RAILWAY COMPANY, LIMITED,
AND
THE ROHILKUND AND KUMAON RAILWAY COMPANY, LIMITED.

The Directors are prepared to receive

Tenders for the Supply of:—

3 FIRST AND SECOND CLASS COMPOSITE BOGIE CARRIAGES,
32 THIRD CLASS BOGIE CARRIAGES,
as per Specification to be seen at the Company's Offices.
Tenders, addressed to the undersigned, and marked "Tender for Carriages" and name of firm tendering, are to be lodged not later than Noon on Friday, the 10th day of August, 1923.
For each Specification a fee of £1 will be charged, which cannot, under any circumstances, be returned.
The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
E. A. NEVILLE,
Managing Director.

237, Gresham House, Old Broad Street,
London, E.C.2.
9th July, 1923. B 64

ABERDEEN CORPORATION WATER WORKS.

EXTENSIONS 1920.

CONTRACT No. 13—NEW AQUEDUCT.

The Town Council of Aberdeen are prepared to receive

Tenders from Competent

Persons willing to enter into a Contract for the TRANSPORTING, LAYING and JOINTING of about 3 miles of 40-inch PIPING and ANCILLARY WORKS between BANCHORY and CRATHES.
The Drawings may be inspected and Specification, Schedule of Quantities and Form of Tender obtained, on and after 12th July, 1923, on application at the Water Engineer's Office, 41½, Union Street, Aberdeen. Early application is desirable, and no specification will be given out after 20th July.
For each Specification a deposit of Five Pounds sterling will be required, which sum will, after a Tender has been accepted, be returned to the Tenderer, provided that he shall have sent in a *bona fide* tender, based on the drawings, specification and schedule of quantities provided, with the schedule of quantities fully priced out in detail, and shall not have withdrawn the same.
Tenders, on the Forms prescribed, and enclosed in securely sealed envelopes, endorsed "Tender for Aqueduct Pipelaying" are to be addressed to the undersigned. No Tender delivered after Five p.m. on 31st July, 1923, will be considered.
The Town Council do not bind themselves to accept the lowest or any Tender.
No person should Tender unless thoroughly experienced in the actual construction of extensive public works.

GEORGE MITCHELL, M.Inst.C.E., F.G.S.,
Water Engineer.

Water Engineer's Office,
41½, Union Street, Aberdeen.
3rd July, 1923. A 991

BOMBAY, BARODA & CENTRAL INDIA RAILWAY COMPANY.

The Directors are prepared to receive up to Noon on Tuesday, 31st July,

Tenders for the Supply of:

1. STEEL RAILS.
2. DOG SPIKES.

Tenders must be made on forms, copies of which, with Specification, can be obtained at these Offices on payment of 20s. each for No. 1 and 10s. each for No. 2 (which will not be returned).
The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices:
91, Petty France,
Westminster, S.W. 1.
6th July, 1923. B 61

COUNTY OF LONDON.

The London County Council Invites

Tenders for the Manufacture,

SUPPLY and ERECTION at Greenwich Power Station, of PIPEWORK and DE-AERATING PLANT.
The Specification, Form of Tender and general conditions may be obtained from the General Manager, London County Council Tramways, Victoria Embankment, W.C.2, upon payment of a deposit of £2. This amount will be returnable only if a *bona fide* Tender is submitted and not withdrawn. Particulars of the work may be obtained at the Tramway Offices, Victoria Embankment, before the payment of the fee.
Tenders must be addressed to the Clerk of the Council and delivered at the County Hall, Westminster Bridge, S.E.1, not later than Four p.m. on Monday, 13th August, 1923. No Tender received after that time will be considered.
The Council does not bind itself to accept the lowest or any Tender.

JAMES BIRD, B 73
Clerk of the London County Council.

THE METROPOLITAN ASYLUMS BOARD invite

Tenders for the Purchase of

ONE only SECOND HAND 5 ton STEAM TRACTOR, tipping body, rubber tyred, horse-power approximately 25, built in 1920, by Clayton Wagons, Ltd., Lincoln, Makers' No. 1062, guaranteed pressure 200 lbs. per sq. in. Insured with M.S.U.A., also two trailers by Messrs. Garrett & Sons.
Forms of Tender upon which alone offers will be considered may be obtained from the undersigned.
The Tractor and Trailers may be inspected at the Brook Fever Hospital, Shooter's Hill, Woolwich, S.E.18, between the hours of ten a.m. and four p.m. on ordinary week-days and ten a.m. and twelve on Saturdays, upon production of the tender form. Tenders addressed as noted on the form must be delivered at the Office of the Board, Victoria Embankment, E.C.4, not later than 2.30 p.m. on Wednesday, July 18th, 1923.

By Order,
G. A. POWELL,
Clerk to the Board.
B 60

THE SOUTH INDIAN RAILWAY COMPANY, LIMITED, are prepared to receive

Tenders for the Supply of:

1. FIREBRICKS.
2. CARRIAGE DOOR HANDLES, HINGES, etc.
3. COPPER TUBE PLATES (FLANGED).
4. STEELWORK FOR BRIDGES.

Specifications and Forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.
Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked: "Tender for Firebricks" (or as the case may be) must be left with the undersigned not later than 12 Noon on Friday, the 27th July, 1923, in respect of Specification Nos. 1, 2 and 3, and not later than 12 noon on Friday, the 3rd August, 1923, in respect of Specification No. 4.
The Directors do not bind themselves to accept the lowest or any Tender.
A charge, which will not be returned, will be made of 2s. 6d. for each copy of Specification No. 1, and of 10s. for each copy of Specifications Nos. 2, 3 and 4.
Copies of the Drawings may be obtained at the Offices of Messrs. ROBERT WHITE & PARTNERS, Consulting Engineers to the Company, 3, Victoria Street, Westminster, S.W. 1.

A. MUIRHEAD,
Managing Director.

91, Petty France, S.W. 1.
9th July, 1923. B 62

ABERDEEN CORPORATION WATER WORKS.

EXTENSIONS 1920.

CONTRACT No. 12—NEW AQUEDUCT.

The Town Council of Aberdeen are prepared to receive

Tenders from Competent

Persons willing to enter into a Contract for the MANUFACTURE and DELIVERY of about 3 miles of 40-inch diameter PIPES and SPECIALS of the following alternative types, viz.:—
(A) Cast Iron.
(B) Mild Steel (Lapwelded).
(C) Reinforced Concrete (Spun and Ordinary).
The Drawings may be inspected and Specification, Schedule of Quantities and Form of Tender obtained, on and after 12th July, 1923, on application at the Water Engineer's Office, 41½, Union Street, Aberdeen. Early application is desirable and no specification will be given out after 20th July.
For each Specification of each type a deposit of Five Pounds sterling will be required, which sum will, after a Tender has been accepted, be returned to the Tenderer, provided that he shall have sent in a *bona fide* Tender, based on the drawings, specification and schedule of quantities provided, with the schedule of quantities fully priced out in detail, and shall not have withdrawn the same.
Tenders, on the Forms prescribed, and enclosed in securely sealed envelopes, endorsed "Tender for New Aqueduct Piping" are to be addressed to the undersigned. No Tender delivered after Five p.m. on the 31st July, 1923, will be considered.
The Town Council do not bind themselves to accept the lowest or any Tender.

GEORGE MITCHELL, M.Inst.C.E., F.G.S.,
Water Engineer.

Water Engineer's Office,
41½, Union Street, Aberdeen.
3rd July, 1923. A 990

SIAM STATE RAILWAYS.

NOTICE.

Sealed Tenders for the Supply

of SUPERSTRUCTURES of STEEL RAILWAY BRIDGES will be received by the undersigned at his Office, in the city of Bangkok, Siam, until 14 o'clock on the 1st November, 1923, at which place and hour the Tenders will be publicly opened and read. Blank tender forms, specifications and plans may be obtained from Messrs. C. P. SANDBERG, 40, Grosvenor Gardens, London, S.W.1, upon payment of 28 shillings per set, which sum will not be refunded.
Right is reserved to reject any or all tenders and to accept any Tender which in the opinion of the undersigned is to the best interests of the Siam State Railways.

General PURACHATRA,
Commissioner General.

Department of State Railways
Bangkok, 7th June, 1923. B 72

CORPORATION OF GREENOCK, ELECTRICITY DEPARTMENT.

Offers are Invited for the

ERECTION of OVERHEAD TRANSMISSION LINES between—
(1) Greenock Electricity Power Station, Dellingburn, Greenock, and the Electricity Power Station, Blackhall Street, Paisley: and
(2) the existing transmission lines belonging to the Burgh of Kilmarnock, near Beith, and the said Power Station at Paisley.
Plans may be seen at the Office of Mr. F. H. WHYSALL, M.I.E.E., Burgh Electrical Engineer, Dellingburn Power Station, Greenock, where specifications and schedules of quantities may be obtained on a deposit of £2 2s. 0d., for each schedule. The deposit will be returned to contractors who make a *bona fide* offer.
Sealed Tenders, endorsed "Offers for Transmission Lines" must be lodged with the subscriber on or before Saturday, 18th instant, at Ten a.m.
The lowest or any offer may not be accepted.

ANDREW NIMMO, Town Clerk.

Municipal Buildings,
Greenock, 11th July, 1923. B 91

APPOINTMENTS OPEN.

CITY OF BRADFORD TECHNICAL COLLEGE.

Applications are Invited for

the APPOINTMENT as ASSISTANT LECTURER in ENGINEERING DRAWING and DESIGN in the College.
An inclusive salary up to £300 per annum will be paid to a candidate of suitable qualifications and experience. Importance will be attached to experience in the Drawing Office.
Full particulars of the appointment and forms of application may be obtained from the Principal of the College, which should be returned to me endorsed "Assistant Lecturer—Technical College," not later than 23rd July, 1923.

N. I. FLEMING, Town Clerk.

Town Hall, Bradford. B 70

A District Locomotive Super-

INTENDENT (Running Department) is REQUIRED for Service on an Indian Railway. The qualifications required are as follows:—
A Public School education, at least three years pupilage or training in the Locomotive Shops of a British Railway Company or locomotive builder, one year in the Drawing Office and an Engineering degree or diploma from a recognised engineering college. Candidates must also have had experience as an Assistant or Divisional Superintendent in charge of the Locomotive Running Department on a railway.
AGE: Up to 34 years.
SALARY: According to age and qualifications, up to Rs. 1,175 per calendar month, with increases according to the rules in force.
TERMS: A three years' agreement in the first instance, and first class free passage to India.
The selected candidate will only be appointed subject to passing a strict medical examination.
Applications can be received by letter only, in which candidates should state their age, whether married or single, and give details of their general and technical education, training and subsequent experience. This information should be given in chronological order, with dates, together with particulars of war service (if any), and copies ONLY of any testimonials, service certificates, etc. (which cannot be returned), should be enclosed with applications. Correspondence cannot be entered into about receipt of applications, and replies will only be sent to applicants who appear to have the qualifications set out above.
Applications should be addressed to the undersigned not later than 28th July, 1923.

MESSRS. RENDEL, PALMER & TRITTON,
12/14, Dartmouth Street,
Westminster, S.W. 1.
B 65

Wanted, a Capable Man to

superintend Steam Engines and Electric Generating Plant, including Motor Drives. Constant work for suitable man. Apply by letter, giving full particulars of experience, age, references, etc., to G. N. HADEN & SONS, LTD., Engineers, Trowbridge. A 909

Wanted, Works Manager by

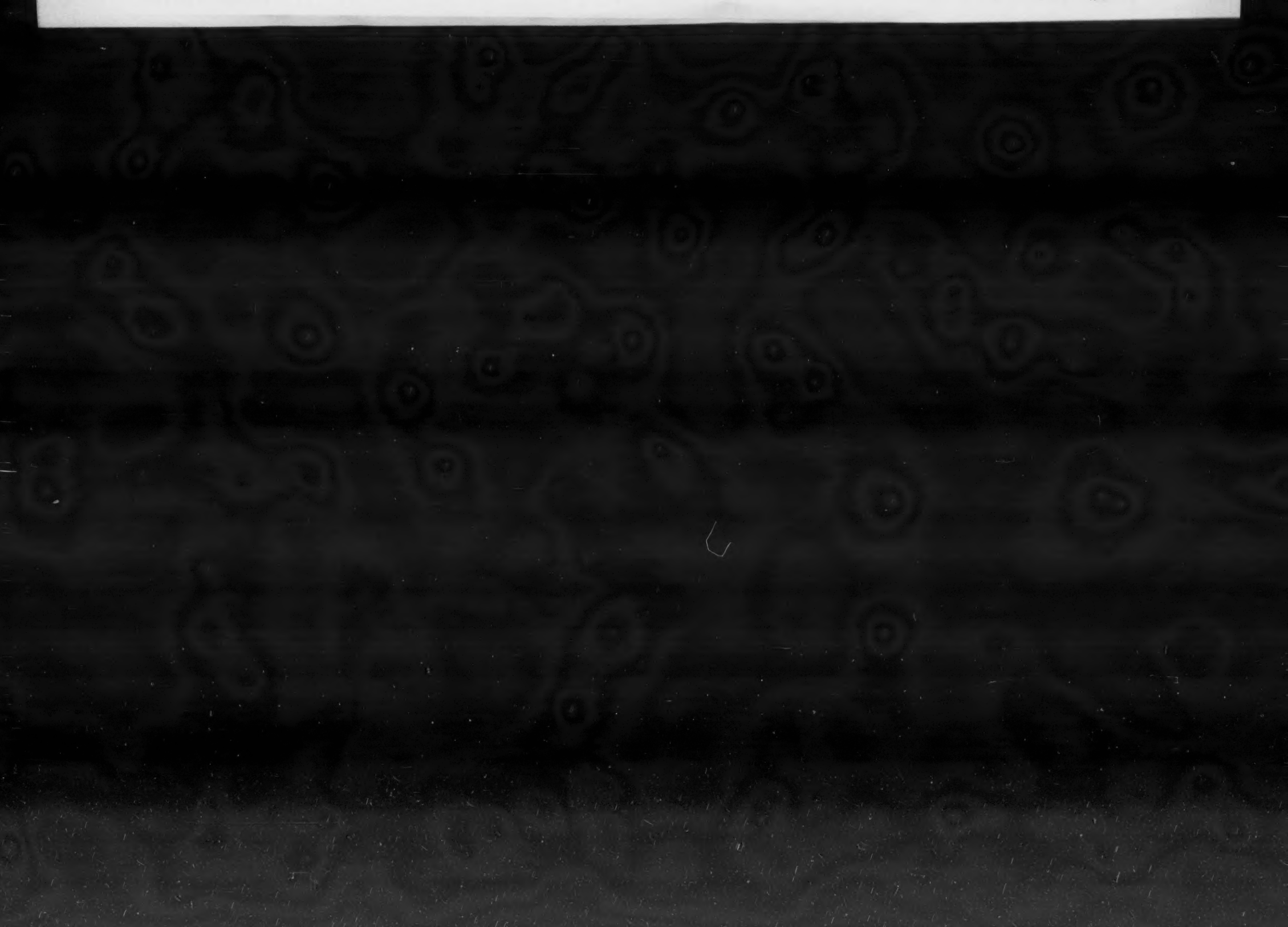
firm of Boiler Makers. None but first-class, up-to-date, and progressive men need apply.—Address, stating age, experience, in the first instance, A 923, Offices of ENGINEERING.

Wanted, for India,

a REPRESENTATIVE with an expert knowledge of Woodworking Machinery. Must be of good social standing. Terms generous to suitable applicant, under 35 preferred, and must be unmarried.—Write, BOX 2948, WILLINGS, 30, King Street, Covent Garden, W.C.2. A 903

A Sound Experienced Man

WANTED, as Superintendent for Electrical Engineering Works. Applications will only be considered from men with actual experience in the handling of departments of a works manufacturing standard electrical machines in quantities; must be used to handling labour working on a piece-work basis, and working to a manufacturing programme against specified delivery dates. State age, experience and salary required.—Address, B 69, Offices of ENGINEERING



THE INTERNATIONAL AIR CONGRESS.

(*Concluded from page* 11.)

THE ordinary business of the International Air Congress was concluded on Friday, the 29th ultimo, and the final meeting took place on Saturday morning, the 30th ultimo, when the resolutions passed by the various groups were submitted for general approval. We give below summaries of some of the papers dealt with during the meeting of Friday together with brief reports of the discussions on these papers. Following these an account of the concluding meeting is given.

MODEL EXPERIMENTS IN AERONAUTICS.

In one section of Group A, of which section Sir J. E. Petavel acted as chairman, two papers relating to model experiments in aeronautics were read and discussed. The first of these, by Mr. R. McKinnon Wood, was entitled "The Reliability of Model Data," and the second, of which Lieutenant-Colonel Robert was the author, bore the title "Méthode d'Experimentation et Utilization des Resultats Obtenus sur Modéles." It having been agreed that the two papers should be discussed jointly, each was read by its author, the chairman afterwards giving a brief summary in English of Lieutenant-Colonel Roberts' paper which was read in French.

Mr. Wood first pointed out that it was the fact that air was viscous which accounted for the differences between the actual flow and the flow calculated in accordance with the theory of hydrodynamics which assumes a non-viscous, incompressible fluid; the effects of compressibility, he said, were unimportant at speeds used in aviation. He deduced from this that model tests may be expected to yield close approximations to full-scale results with respect to lift, except in regard to the stalling value. Their usefulness with regard to the drag of stream line bodies, he said, would be less, fine bodies exhibiting a steady decrease in drag as the value of $V L/\nu$ is increased and bluffer bodies a less regular variation; bodies having a marked angularity of outline, he said, should show little scale effect. These inferences were largely confirmed by the results of tests in British wind channels the size and speed of which had increased so that the values of $V L/\nu$ at which tests could be carried out had increased from $0{\cdot}063 \times 10^6$ to $0{\cdot}19 \times 10^6$ The conclusive test, however, was provided by the comparisons of measurements made in flight with the results of wind channel tests. When the latter are corrected by Prandtl's method for the interference effect of the wind channel walls, the agreement between model and full-scale results is remarkably close.

In the case of a B.E.2E machine, a model of which was tested at a value of $V L/\nu$ of $0{\cdot}275 \times 10^6$, the lift of the full-size machine was predicted from the model test with a high degree of accuracy even at stalling incidences, and the drag was only over-estimated by about 5 per cent. of the minimum total drag of the machine. The wings, it should be mentioned, were of the R.A.F. 14 section. The experiments on the moments on the wing were in rather less satisfactory agreement, the centre of pressure being a little further forward on the machine than on the model and the difference amounting to from 2 per cent. to 5 per cent. of the wing chord. In similar tests made with a highly-cambered wing of R.A.F. 19 section, however, the full-scale lift was found to be considerably less at all angles than that obtained from the model, although the drags were in good agreement; the drag of this wing, it may be mentioned, is prohibitively high. The author concludes that British wind-channel practice gives satisfactory results for the common forms of British aeroplanes, but that for development along lines involving the use of thick wings, an increase in the range of $V L/\nu$ is needed; he referred in this connection to the compressed-air wind channel at Langley Fields, mentioned on page 748 of our last volume. The author finally discussed the questions of the accuracy of the model and the accurate representation of the motion of the machine and also dealt with the effects of turbulence.

In his paper, Lieutenant-Colonel Robert dealt with the causes of discrepancies in model experiments and with the means taken for their elimination in French aerodynamic laboratories. He stated that supports attached to the upper surface of the wings gave rise to important interference effects which varied from one section to another. On the other hand, accurate measurements showed that rigid connections of small section and of sufficient length had but little effect if fitted on the under surface of the wing, and this was also true for wire supports. These two methods of support were therefore adopted to the exclusion of all others. Tests on an aerofoil section were carried out in May, 1922, and had to be suspended for a month; on renewing the tests, the resistance of the model was found to have decreased by 15 per cent. The difference was too great to be attributed to experimental errors, and consequently the resistance of the wires was measured again and it was found that this resistance had decreased by about 5 per cent., which fully explained the decrease of 15 per cent. on the model. This decrease of resistance of the wires was due to their having become slightly tarnished in the interval between the two tests. The large wind tunnel recently completed in France for the Aeronautical Department would enable air velocities of 80 m. per second to be obtained, the tunnel being 3 m. in diameter. Wind tunnels tests on models, the author stated, were, so far, the only practical means of investigating aerodynamic problems and if the necessary precautions were taken, the results obtained were perfectly reliable. They constituted a useful means for controlling theoretical investigations and were a valuable aid to progress. They could be utilised, with a negligible error, provided that the product $V L$ in the model experiment had a sufficiently high value (3,000 minimum, 6,000 or more for a high degree of accuracy). This value could be reached for the main parts of the aeroplane, such as the wings and the fuselage, but not for the small details. The law of dynamic similarity could not therefore be applied as a whole, and a different procedure was required for dealing with the large and small parts. There would thus remain an error due to interference. It would therefore be necessary to know the values of the interferences in different cases; researches had already been made on the subject, which was a difficult one, and the researches were not yet completed.

The discussion on the two papers summarised above was opened by Mr. E. F. Relf, of the National Physical Laboratory, who referred first to the question of the effect of the resistance of the wires used for supporting models in the wind channel upon the accuracy of the results. In the case of a large model tested in the 14-ft. by 7-ft. duplex wind channel at the Laboratory, he said, the resistance of the wires amounted to only 4 per cent. of the minimum drag of the model, adding that the error due to this cause would be less than 0·5 per cent. The extension of the wires was such that, under the worst conditions, the resulting error in the angle of incidence would be about 0·1 deg. The same angle, he said, represented the maximum deviation in the direction of the wind from the axis of the channel over the whole of the working section, and these small errors could all be allowed for. The effect of turbulence, he thought, might be further investigated. He explained, however, that he had himself placed a wire screen in front of a model in a wind channel and found that it had little or no effect in the case of a model aerofoil, even on the minimum drag; with an airship model, however, the effect was considerable. Full-scale work, he concluded, must always be the final appeal as to the accuracy of model tests, and it was of vital importance to push on with the former in order to provide a check wherever possible.

Lieutenant-Colonel Robert inquired of Mr. Wood as to the corrections made in the model results used for comparison with the full-size machine fitted with a wing of R.A.F. 14 section, and Mr. Wood at once explained that the full-size machine had been tested by gliding with the propeller fixed and that the model had been tested with the struts in position but without bracing wires. The curves for the model given in the paper, he said, had been corrected for the effect of the channel walls, but not for scale effect; neither had the drag of the bracing wires been added. Lieutenant-Colonel Robert, in thanking Mr. Wood for this explanation, expressed his appreciation of the excellent results obtained at Farnborough. Mr. Wood afterwards referred to the use of the quantity $V L$, pointing out that the value of this quantity depended upon the system of units employed, whereas the quantity $V L/\nu$ was non-dimensional. He added that the fact that $V L/\nu$ had a value of the order of a million indicated that the viscosity was a small quantity. The important point was that viscosity had to be considered, although its actual magnitude was unimportant.

The programme for the section having thus been completed the meeting terminated.

LUBRICATION.

On Friday morning Group B met under the chairmanship of Admiral Sir E. Slade. Dr. T. E. Stanton, F.R.S., was the author of the first paper taken, which was entitled "The Nature of Lubrication in Engineering Practice." In this paper Dr. Stanton said that in most practical cases lubrication was not effected on Osborne Reynolds' principle but on another which had been called "boundary lubrication." He stated that "it was now known that hard surfaces could slip over each other without abrasion, without the existence of a separating film of more than molecular dimensions," and "that there can exist between rubbing surfaces a condition of steady lubrication whose characteristics are totally different from those of the Reynolds' type." In these conditions of boundary lubrication the law of solid friction was strictly followed, the friction for a given load being independent of the relative speed and area of contact. He stated that the attempt was made in 1922 to realise these conditions of boundary lubrication with a journal working in a bush so large that the arc of contact extended over but 14 deg., but although pressures of 3½ tons per square inch were reached the observations showed that in this case the lubrication was effected on Reynolds' system. A further experiment was therefore tried, in which a pendulum was hung from a rocking shaft resting in a cylindrical journal. To ensure easy access of the lubricant both brass and journal were grooved with spiral grooves of which those in the brass crossed those in the journal at right angles. A copious supply of lubricant was provided for. In making the experiment the pendulum was set in oscillation and its rate of damping determined. The results showed that the frictional resistance was independent of the speed, which Dr. Stanton stated, indicated that the lubrication was of the boundary type. It was also found that the friction was directly proportional to the load. With castor oil, as the lubricant. the journal being of hard steel and the brass of phosphor-bronze, the coefficient of friction was 0·092, and was constant, being the same for pressures of 2,000 lb. and 1,000 lb. per square inch. With Bayonne mineral oil the coefficient of friction was 0·128, but on adding to this oil 1 per cent. of oleic acid this figure was reduced by 17 per cent. A further addition of acid gave no further improvement.

The discussion was opened by Mr. E. B. Martin, who read a letter from Mr. Southcombe in which the writer expressed his agreement with Dr. Stanton's conclusions, and pointed out that three years ago Messrs. Wells and Southcombe had shown that small additions of fatty acids to mineral oils greatly improved their lubricating properties, and it was very satisfactory to have this conclusion confirmed by Dr. Stanton.

Mr. H. M. Martin, who spoke next, said that until crucial experiments had been made it was natural that different people should interpret observations in different ways, and he made no apology therefore for saying that there were few statements of opinion in Dr. Stanton's paper which he was prepared to accept. He knew of no facts which demonstrated the reality of boundary lubrication, though many showed the importance of adsorption. It had never yet been proved that lubrication was possible with an oil film only one or two molecules thick. The thickness stated was in actual fact a mean value averaged over the whole of the opposing surfaces which were never truly parallel within a limit of error corresponding to a thickness of at the very least 100 molecules. With such surfaces, surface tension would collect surplus lubricant round the high points, and these local concentrations would make lubrication possible on Osborne Reynolds' principle.

Osborne Reynolds, moreover, held that his principle applied even to imperfect lubrication in which case the load was, he considered, carried by numerous detached "active areas," and not by the brass as a whole. Reynolds had also stated that in these conditions the friction would be independent of the speed and proportional to the load, relationships which were now claimed as characteristic of boundary lubrication. The speaker believed that the new experiments described in Dr. Stanton's paper were readily explainable by Osborne Reynolds' principle, and in support of this cited some observations by Mr. H. T. Newbigin. Experimenting with flat parallel surfaces, Mr. Newbigin had found that, in general, lubrication broke down rapidly, but he had at times been mystified by the anomalous behaviour of individual plates, with which lubrication was maintained in a very remarkable way. Ultimately, it was noticed that the plates giving these exceptional results had rounded edges, thus making lubrication possible on Osborne Reynolds' principle. When these rounded edges were removed and sharp corners substituted, lubrication failed in the normal way. The speaker believed that the rounded edges of Dr. Stanton's grooves were responsible for the lubrication observed, which was thus effected on Osborne Reynolds' principle. As for the speed factor the argument put forward in the paper was in flat contradiction to the author's argument in his Thomas Hawkesley lecture. In that, he had pointed out that the fact that in certain cases journal friction was found to be nearly independent of the viscosity of the lubricant was not inconsistent with Reynolds' theory, since with high viscosities the oil film was thicker. The author now argued that the fact that in his new experiments the resistance was independent of the speed showed that Reynolds' theory was inapplicable. In Reynolds' equations, however, the viscosity and the speed entered in exactly the same way and the same argument must apply to both. According to these equations, under similar geometric conditions the friction was proportional to the product of the viscosity and the speed, and inversely proportional to the thickness of the oil film. With slow speeds the film was thinner, and this compensated for the lower speed. In the ultimate, lubrication must be a mechanical process, and interpretable, therefore, in terms of mechanism. When advocates of the "boundary lubrication" theory were able to picture a corresponding mechanism it would be time enough to take them seriously.

Mr. Auden, who spoke next, said that experiments with the authors' apparatus using a white metal bush and loads of from 900 lb. to 1,000 lb. per square inch would be of interest. As regarded the criticism of oil grooves as applied to continuously-lubricated bearings, he did not see how it would be possible without them to get the oil into the bearing.

Mr. F. J. Hookham said that he considered that the apparatus described by the author might prove very useful for oil testing, but asked whether different observers and different machines would get the same results. From his experience with the Thurston machine he thought this improbable, and that the results would be affected by the relative sharpness of the edges of the grooves.

In reply, Dr. Stanton said Mr. H. M. Martin was well recognised as a strong believer in the sufficiency of the Reynold's theory to cover all cases of continuous fluid lubrication. From his own experimental work, however, the speaker believed that there were the two sharply differentiated methods of continuous lubrication. He added that in the experiments described in his Hawksley lecture time was required to form the film of lubricant, as much as 3 or 4 minutes being required for its complete establishment. In reply to Mr. Hookham he would say that he did not put forward the coefficients of friction found as absolute constants, though they were probably not far from it, but the relative values were reliable and would, he thought, be confirmed by different observers using the same machine.

Mr. Elliott A. Evans than read a paper on "Some Physical Properties of Lubricants." In this the author drew attention to the fact that physical data as to the viscosity, specific gravity and flashpoint of an oil were insufficient to fix its practical value. In illustration of this, he gave the following figures as to two oils used for Diesel engine lubrication under exactly similar conditions :—

	A.	B.
Flash-point (closed) ...	408 deg. F.	410 deg. F.
Flash-point (open)... ...	430 deg.	440 deg.
Fire-point	484 deg.	515 deg.
Vapourisation-point ...	245 deg.	265 deg.
Viscosity at 60 deg. ...	843 sec.	1,060 sec.
Viscosity at 80 deg. ...	435 sec.	525 sec.
Viscosity at 100 deg. ...	246 sec.	291 sec.
Viscosity at 200 deg. ...	49 sec.	54 sec.
Viscosity at 250 deg. ...	39 sec.	42 sec.
Specific gravity at 60 deg.	0·872 sec.	0·878 sec.

	A.	B.
Hours run	1,720	3,001¼
Units generated	166,308	334,810
Load factor (per cent.) ...	64	74
Oil per 100 running hours	16·6 gallons	5·3 galls.
Oil per 1,000 units ...	1·74 galls.	0·48 galls.

There were, he pointed out, small differences between the physical data of the two oils, but these were insufficient to create the impression that the two oils were materially different. The difference between the respective consumptions was, however, very marked indeed, showing conclusively that some material difference existed. Therefore, other evidence was necessary before one could express an opinion upon their relative merits. Hence the necessity for caution in judging a lubricant upon its physical characteristics as customarily determined. One further set of results obtained upon these oils was of great interest to the Diesel engine user, namely, that of the free acid found; figures for which are tabulated below :—

	A.	B.
Water from low-pressure purge pot	Per Cent. 0·074	Per Cent. 0·049
Water from high pressure purge pot	0·083	0·073
Used oil	0·02	0·0078

Lubrication was, he said, in many cases more of an art than a science, and much had to be settled by practical experience. An important point was the adhesion of the lubricant to the surfaces lubricated. Viscosity was also of importance, and Mr. Hyde had shown that it increased greatly with the pressure, especially in the case of mineral oils. The author believed that this increase was probably closely connected with the compressibility of the oil, being greater the more compressible the oil. He suggested that attempts to use mineral oils in place of castor-oil for aircraft engines should be pursued with caution, since a failure might have fatal results. In Mr. Hyde's experiments with the Lanchester worm gear tester, the efficiency diminished with rise of temperature in all cases save that in which the lubricant was castor oil, with which there was some increase of efficiency as the temperature rose.

The discussion was opened by Dr. Thole, who questioned whether there was any direct connection between the compressibility of an oil and the increase of its viscosity with rise of pressure. Speaking from memory, he believed that the compressibility of fatty oils did not differ much from that of mineral oils, yet the viscosity of the latter increased far more rapidly with rise of pressure. As for aircraft engine lubrication, castor oil had both advantages and disadvantages, and he thought that it would be possible, as the result of further research, to replace it by mineral oils. There was no danger in such experiments as the tests were made with the engine in the shed and not in the air.

Mr. Chalmers, who followed, said that the two specifications given in the paper were disconcerting, as the physical qualities tabulated for the two oils were practically identical, yet the one oil was much superior to the other. The further figures given showing the greater acidity of the one oil after use seemed to indicate that the only way to differentiate between the two was to use them and judge by the results. In many cases the viscosity of an oil changed rapidly with the temperature, but mineral oils were obtainable which retained a good body at cylinder temperatures, whilst not excessively viscous at normal temperatures. It should be added that mineral oils came from different regions, and that the term mineral oil was therefore far too indefinite to be characteristic. Some mineral oils were being produced which were as good as castor oil.

Mr. Auden said that he had found a paste made up of flowers of sulphur prove a very satisfactory lubricant for a troublesome footstep bearing.

Dr. E. Gooday said that during the war mineral oils had been largely used for lubricating aircraft engines, and this tendency was increasing because all fixed oils were liable to decompose and carbonise. In making comparisons, moreover, it should be borne in mind that whilst the fixed oils had definite characteristics, mineral oils were blended. He agreed with the author that it was impossible to fix *a priori* a definite specification for lubricating oils. The results already attained had been largely reached by a process of trial and error. Specifications might in fact be classed as protective and selective, and whilst it was impossible to draw up a specification which would "select" the best oil possible for a particular purpose, it was practicable to frame a specification which would protect the user against the supply of really unsuitable oils.

In calling on Mr. Evans to reply, Admiral Slade said the question of oil specifications was of extreme importance.

In reply Mr. Evans said that in suggesting that the increase of viscosity with pressure, would depend on the compressibility he had been venturing on prophesy which he had based on certain theoretical considerations. He admitted that castor oil did suffer from the drawbacks of gumming and carbonisation, but he thought that these could be pretty well eliminated. Putting such drawbacks on one side the evidence seemed pretty conclusive that there was a greater margin of safety with castor oil than with mineral oils. He fully agreed with Dr. Gooday whose classification of specifications as protective or selective he thought excellent. It should not be thought that mineral oils did not produce acid, as in steam turbine practice it had been found necessary to wash the used oils to keep this acidity below a dangerous concentration.

A third paper, by Professor M. D. Hersey, Physicist, United States Bureau of Mines, was taken as read. It described summarily experiments on the "Viscosity of Lubricants at High Pressures and Temperature," and might be regarded as in some sort an extension of the experiments made by Mr. Hyde for the lubrication committee with the exceedingly ingenious apparatus designed by Dr. Stanton. In Professor Hersey's research a rolling ball viscometer was used and pressures as high as 18 tons or 20 tons per square inch were attained. At these very high pressures the differences found by Mr. Hyde between fixed and mineral oils were much less pronounced.

Dr. Stanton was the only speaker on this paper, and he expressed a wish for more details concerning the apparatus used.

Aerial Surveying.

At a meeting of group C, held in the afternoon under the chairmanship of Lieutenant-Colonel J. T. C. Moore-Brabazon, M.P., a paper on "Aerial Surveying" was read by Professor B. Melvill-Jones. The object of the paper was to indicate the problems that require solution and the principal difficulties to be faced in the application of aerial methods to surveying, particularly for the construction of moderately accurate maps of large areas of unsurveyed, or unexplored, country. The two main difficulties, he said, were to cover the whole area with reasonable economy of time and material and to convert the photographic records into a true map. It was necessary to cover the ground without allowing the separate photographs to overlap too much and without leaving gaps, to cover which a separate flight might have to be made. He pointed out the difficulties experienced by the pilot in flying on a straight course while taking photographs, but mentioned that methods had been developed which enabled an area of 100 sq. miles to be covered in 70 minutes' flying time by taking vertical photographs from a height of 10,000 ft. To obtain a true plan of the ground from the photographs taken, it was generally necessary to know the position and orientation of the camera at the moment of exposure, and this might be obtained from evidence in the photograph itself or by independent means. For the former it was necessary to know the exact positions of three points in each photograph, and if this information could be obtained from a ground survey, or by other means, the method could be

developed to give results of a high order of accuracy, although it involved heavy office work. The method was particularly suitable for the construction of detail maps of towns and other small areas. The alternative method of obtaining the position and orientation of the camera by independent means was not so accurate, but gave results of fair accuracy with a comparatively small amount of flying and office work per square mile; it was therefore particularly suitable for mapping large areas of undeveloped country.

The author then discussed the methods by which the position of the camera could be determined by independent means, mentioning that it could be set vertical to within about 1 deg. by means of spirit levels. The height, he said, could be estimated by an aneroid with an error of less than a half per cent. and the position in plan could be estimated by navigational methods; the probable errors of the latter, he added, were now being investigated at Cambridge. He also mentioned that, if the ground were flat, accurate maps could be constructed without knowledge of the position of the camera in plan or its orientation in azimuth. Using this method over country in which the variations in level do not exceed 500 ft., maps could be compiled from contact prints so that the distortion in each area of 100 sq. miles is less than 100 yards. This could be done without any help from the ground, but the maps could be made to fit any number of ground-surveyed control prints, if such were available. In conclusion, the author stated that experiments were now in progress at Cambridge to determine the possibility of locating the position of the camera in plan by navigational methods with sufficient accuracy to make moderately correct maps of hilly country by means of oblique photographs.

The discussion on this paper was opened by Lieutenant-Colonel Winterbotham, who, in the course of his remarks, referred to the fact that it was not possible to do away with triangulation or some form of ground control. If photographs were taken without regard to the ground it was not possible to state which part they represented, and that difficulty seemed to be insuperable. With regard to the survey of hilly ground by means of oblique photographs, he called attention to the difficulty of recognising the same point in two photographs, and also to the possibility of leaving gaps. It had frequently been stated that the cost of aerial surveying was but a small fraction of that of ground surveying, but actually it appeared to be greater. Major MacLeod, who also spoke, mentioned that reconnaissance surveys, which would be required as a preliminary to the development of some area, showed much more detail than was at first required, but could subsequently be employed for the preparation of accurate large-scale maps that might be needed later. He also referred to the use of the aneroid for obtaining the height, pointing out that this gave the height above the aerodrome from which the machine started and not the height above the ground over which the machine was actually flying. The chairman asked what the author considered to be the nearest approach to the ideal camera for surveying work, and also referred to the distortion arising from the use of focal-plane shutters.

The author, who then replied, remarked that unless the ground was quite inaccessible, he would not contemplate carrying out aerial survey work without ground co-operation; he wished, however, to reduce this to a minimum. The method of surveying by means of oblique photographs had not, so far, been developed. He was aware of the difficulty of locating the same point in two photographs, but did not yet know how much trouble would arise from this cause. He had particularly avoided mentioning the matter of cost which depended upon many unknown factors such as availability of aerodromes and dangers from forced landings. He thanked Major MacLeod for having called attention to the point which he had omitted to mention, viz., the subsequent use of preliminary photographic surveys, and, in answer to the chairman, remarked that he was not an expert in the subject from the photographic point of view. He had been using a 5 in. by 4 in. camera with a 6-in. lens, and, while it was true that a focal-plane shutter caused some distortion, it did not seem to be serious. The errors, he thought, were mainly due to the rotation of the camera during exposure; a between-lens shutter would, no doubt, be preferable.

AERIAL NAVIGATION AND JAPAN.

A paper by Major W. Jikemura entitled "Aerial Navigation and Japan" which formed the remaining item on the programme of the section, was cancelled, since it could not be prepared in time. The author, however, attended the meeting and briefly outlined the subject. From this it appeared that little progress in commercial aviation had, so far, been made in Japan, but that an air service between this country and Japan was under consideration. In thanking the author, the chairman remarked that the shortest route to Japan would be *via* the North Pole, adding that the Arctic regions did not present the same barrier to aerial navigation that they did to other forms of transport.

This concluded the business of the section and the meeting then terminated.

AIRSHIPS.

Group D met under the chairmanship of Lieutenant-Colonel M. O'Gorman for the consideration of four papers on airships. The first was submitted by Major G. H. Scott, who dealt with "The Commercial Aspect of Airship Transport."

For purposes of comparison with the results attainable in transport with an airship, the times taken by a typical steamship in reaching various ports while running to the East were given. It was stated that such a vessel would reach Port Said in 6 days, Bombay in 15 days, Singapore in 24 days, and Perth, Australia, in 28 days. Speeding-up the service was economically impossible without the grant of subsidies. An airship of 5,000,000 cub. ft. capacity, having a speed of 80 m.p.h., could carry 200 passengers, and 11 tons of mails and freight, on non-stop flights up to 2,500 miles length, with an average saving in time over the steamship of 66 per cent.

In the initial stages of the development of an airship transport scheme, Government assistance was essential. In the early days the volume of the traffic would not suffice to meet the expenses. Heavy expenditure in the provision of ground organisation and the erection of bases on the route was necessary, and some time must elapse before the public became fully alive to the value of the service and would make extensive use of its facilities. The utility of the airship for military defensive and offensive operations to a country having long sea trading routes, must be considered in relationship to subsidies. By the building up of a scheme of commercial transport the airships would be available at any time of need. Major Scott compared the running costs of an airship of 150 tons displacement with those of a light cruiser. If the same area was patrolled by each, the running cost of the light cruiser would be 70 times that of the airship, and the capital cost of the sea vessel would be six times as great.

A comparison of the two types of aircraft showed that they must have entirely different spheres of activity, which were complementary to each other rather than in rivalry. The full speed range of an airship was nine times that of a large aeroplane, and the economic ranges had the same relationship. For long distances where heavy loads were available the airship had great advantages, while the aeroplane was the more efficient on short distance services. The growth of the use of airships would be followed by the institution of a feeder system making use of aeroplanes. The head resistance, horse-power and fuel consumption of an airship varied as the two-thirds power of the capacity, whereas the lift available for freight and fuel varied directly with the capacity. In consequence of that, although the percentage of disposable lift may not increase with size of ship, at constant speed the percentage lift available for freight would do so.

From the constructional standpoint, an airship admitted of a certain measure of mass production. In the R. 36, the total number of girders was 2,481, but they were of only eight types, and 98 per cent of them were straight. Bracing pieces were cut down to seven types on that airship, although their number exceeded 300,000. A modern rigid airship was produced consequently from a large number of standard and simple parts. As it was possible to procure fabrics with a skin substitute, the costly labour in applying goldbeaters' skin to the fabric was eliminated. Economical production was thus becoming a possibility and the costs might be expected to be reduced considerably in the future.

As the fuel was consumed in the engines, the gross weight of an airship was decreased and consequently hydrogen must be released from the gasbags. Mr. Ricardo had shown that it was possible to consume that hydrogen in the petrol engine, and, in his experimental work, found that the system was efficient, as by its use petrol consumption could be reduced from 0·55 lb. to 0·35 lb. per horse-power hour. Later experimental investigations established that there were similar actions when kerosene was used in place of petrol. The substitution of heavy oils would reduce the cost of fuel very greatly.

The equipment of an airship, Major Scott suggested, must be made so that the engines are detachable and repairs are possible to the hull, outer cover and gasbags, without interfering with the flying operations. Until recently, the limiting factor in the usefulness of an airship was the handling on the ground. The design of suitable mooring masts had removed this source of difficulty, and their use had shown that mooring and leaving was possible in weather too bad for handling out of and into a shed. With the installation of hydrogen mains, fuel pumps, water pumps and pipes on the mast structure, replenishing was quite simple. Lifts for passengers and luggage would be provided, and a covered way to the airship arranged so that the passengers would not see the ground until they were in the car.

Major Scott discussed questions relating to the site for an airship base, the effects of wind, tempera ture, humidity, rain and other conditions on airship running and mooring. His paper was accompanied by an appendix in which the figures were given for the running costs on a ton-mile basis for a service employing five ships of 150 tons displacement, on a route where there would be two docking or shed bases and two mooring-mast bases. From the figures given it was seen that the cost per ton-mile would be 4·85*d.* when working on full load, or twice that figure on half load. Taking the half-load condition and assuming six passengers per ton, the cost per passenger-mile would be 1·61*d.*, and at a charge of 2*d.* per passenger-mile the profit on capital would equal 10·6 per cent. Those figures correspond to a mail charge of 1·34*d.* per letter for service between Britain and India.

In opening the discussion, the chairman, Lieut.-Colonel O'Gorman referred to the costly adventures in taking up and dropping repeatedly, the construction of airships. Mr. Larsen asked for further information on mooring in gusty weather, as that was a prevalent condition in his country. A slipping clutch on the drum of the winding gear of a mooring mast might be useful in effecting a solution of the troublesome conditions due to gusty weather.

Mr. Sams, of the Indian Post Office, welcomed the paper as a great contribution towards improving the transport between the home country and the outlying parts of the Empire. Governments were very shy about the subsidy question unless concrete propositions could be put before them. To take full advantage of an airship scheme, aeroplanes would be put into increasing use as feeders. The proposals showed the possibility of a daily service to India. Information as to how many years would be necessary for the complete service to be put into action would be valuable.

Wing-Commander Cave-Brown-Cave spoke of the improving conditions for mooring and housing as the wind increased, and said the greatest troubles were experienced at times when there was no wind, but rapid changes of temperature. The necessity for placing an airship base near the railway was not obvious. Information regarding the possibilities of burning hydrogen with crude oil would be welcomed. Great reductions had been made in the cost of hydrogen. Mr. Kennedy asked if it was not advisable to use helium for the sake of safety.

Brigadier-General Williamson said that the figures regarding the possibilities of a cheap,

20,000-KW. TURBO-ALTERNATOR; SHANGHAI MUNICIPAL ELECTRICITY WORKS.

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(*For Description, see opposite Page.*)

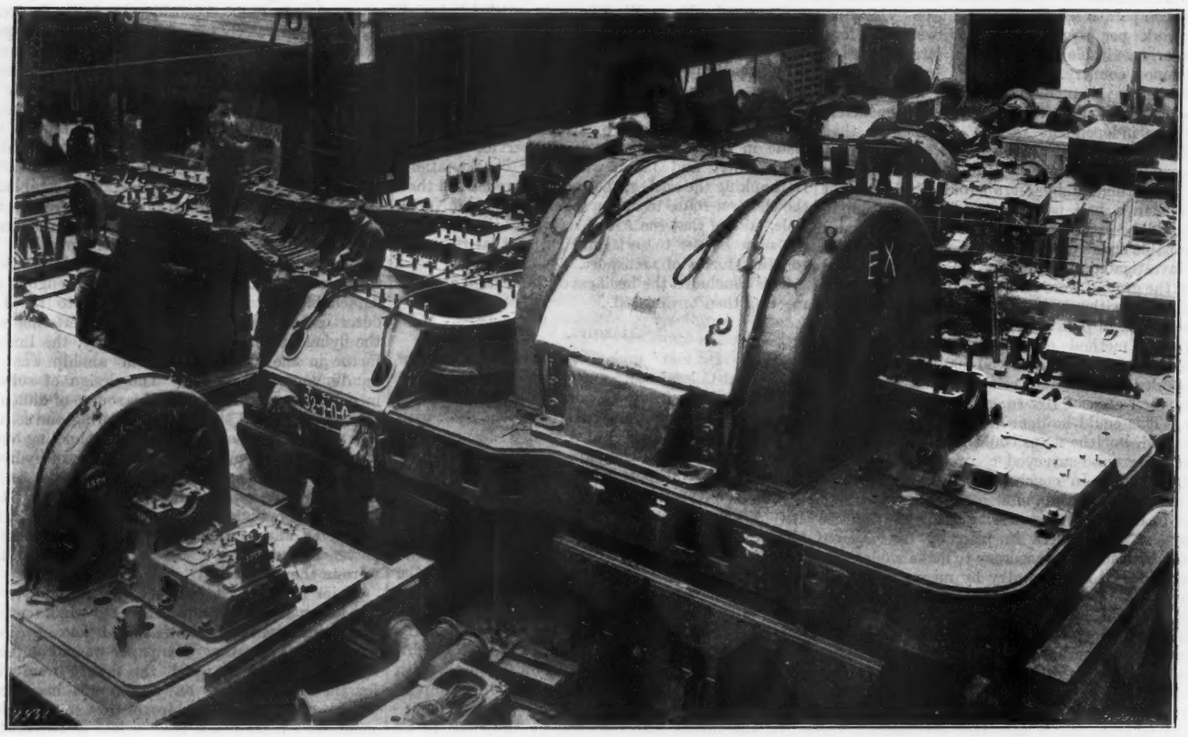

FIG. 1. TURBO-ALTERNATOR IN COURSE OF ERECTION.

accelerated mail service to India greatly impressed him. The proposals put Imperial communication on an entirely new footing. Mr. A. E. L. Chorlton thought that combined burning of hydrogen and crude oil was quite a possibility.

Lieutenant-Colonel O'Gorman, on closing the discussion, referred to the question of air mails, and said that inquiries had been started from the aeroplane standpoint, but the airship claims were imperative and must be considered immediately.

In reply, Major Scott said that the proposal of the use of a winch with a slipping clutch to meet the conditions when the wind was gusty, was not new, and such a device had already been designed. If the freight were available a daily service could be established between India and Britain, but it would take two to three years from the time of deciding on a scheme to have it in actual operation. The advantage of having the airship base beside the railway was that the services could be worked in association. The cost of production of helium put its use, at present, quite out of consideration. Petrol engines are the real source of danger of fire. The hydrogen bags could be surrounded by an atmosphere of inert gas to reduce the dangers of a general fire.

The second paper read on Friday morning in this section was on "The Hulls of Rigid Airships," and was presented by Lieutenant-Colonel V. C. Richmond. In the early part of his paper the author stated that there were many possible variables in the construction of a dirigible, but any modifications suggested must be viewed in the light of the external loads and the stresses set up in the individual members. The requisite knowledge was still incomplete, more especially as to the aerodynamic forces acting on the hull in times of manœuvring and the validity of any possible basis of stress determination in such a complicated structure. The theoretical aspect had been advanced considerably by the investigations connected with the accident to R. 38, and also in America in the strength investigations relating to Z.R. 1. Redundancy made stress determination difficult, but was necessary to counteract the effects of reversal of stress. The actions of aerodynamic forces were of equal, if not greater, importance than those of static forces. The hull must be made of equal strength in all radial planes passing through the axis. Of the difficulties in airship design, some were due to the pressure of the gas bags on the wiring and the consequent forces exerted on the structural members at the point of attachment of the wires. Rigid airship construction had reached the stage where ample structural strength was not incompatible with useful performance for commercial or naval purposes. Model experiments in wind channels had provided useful data for design, but more knowledge of scale effect was still required. The paper was accompanied by a number of appendices containing mathematical investigations of stresses.

In opening the discussion, the chairman, Lieut.-Col. O'Gorman, said that one piece of work which appeared to be necessary was pressure plotting on a full-scale during manœuvres. The discussion in which Major Southwell, Commander Burney, Professor Bairstow and Commander Cave-Brown-Cave took part, was largely devoted to recent research work and the necessity for its continuance. In his reply, Colonel Richmond agreed with the statements of the various speakers regarding the value of investigation work and emphasised it by stating that, if early success was to be assured, designers must be possessed of such knowledge that there could be no failure with the first commercial machine.

In the afternoon Lieutenant O'Gorman again took the chair, and Wing-Commander Cave-Brown-Cave read a paper contributed by Mr. Umberto Nobile on "Recent Progress in Airship Construction in Italy." The paper dealt with the airships S.C.A., O.S. and P.M., which were of the semi-rigid type with stiffened hulls, secured by superficial metal framing, to knuckles of which the boat, carrying the controls, pilots and engines, was suspended by steel cables. The most important refinement tested out in their construction was in the tail ends of the hulls, which were stiffened by means of metal reticules of wide mesh, having the elements placed along the parallels and meridian of the hulls.

The last paper of the series concerned "The Effect of Bow Stiffeners in Non-Rigid Airships." It was read by Major Scott in the absence of the author, Professor Edward P. Warner. If no bow stiffeners were used in non-rigid airships, the inside pressure would have to be greater than the dynamic pressure against the outside of the envelope at every point. Calculations were given for two envelopes for which pressure distribution data were available, and diagrams showing the effects of the bow stiffeners on the internal pressures required were submitted for consideration.

Commander Cave-Brown-Cave pointed out that the pressure distribution over the nose was very different when the airship was turning from that which occurred when going ahead. He described a nose stiffener consisting of a spar, the ends of which were connected to a ring on the envelope surrounding the middle part of the length of the spar.

This completed the programme for Group D and the meeting then terminated.

CONCLUDING MEETING.

As previously mentioned, the concluding meeting of the Congress was held on Saturday morning, the 30th ultimo. The chairman, Sir Samuel Hoare, Bart., Secretary of State for Air, first put to the meeting *seriatim* a number of resolutions brought forward at the various sectional meetings. These resolutions, all of which were passed without discussion, were to the effect that a uniform scheme for posting weather forecasts in all air stations should be evolved; the general principles of private international law relating to the air should be studied and

20,000-KW. TURBO-ALTERNATOR; SHANGHAI MUNICIPAL ELECTRICITY WORKS.

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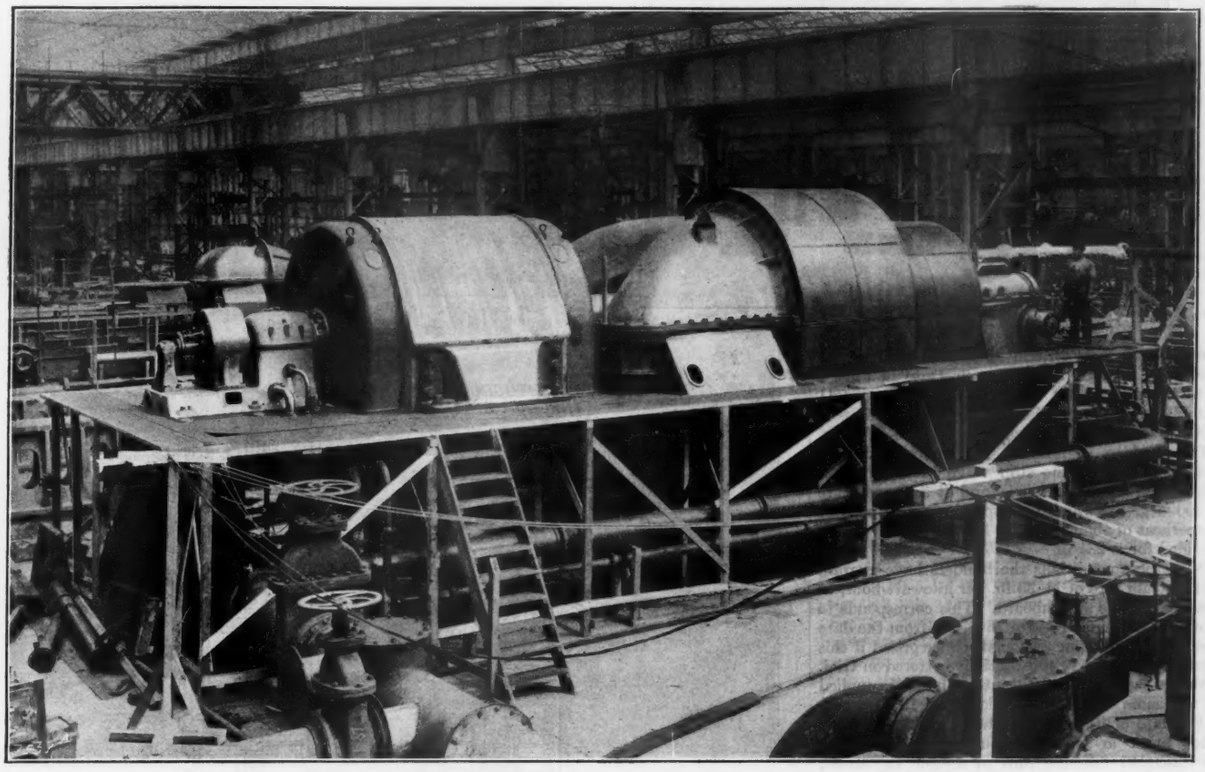

FIG. 2. TURBO-ALTERNATOR ERECTED ON TEST BED.

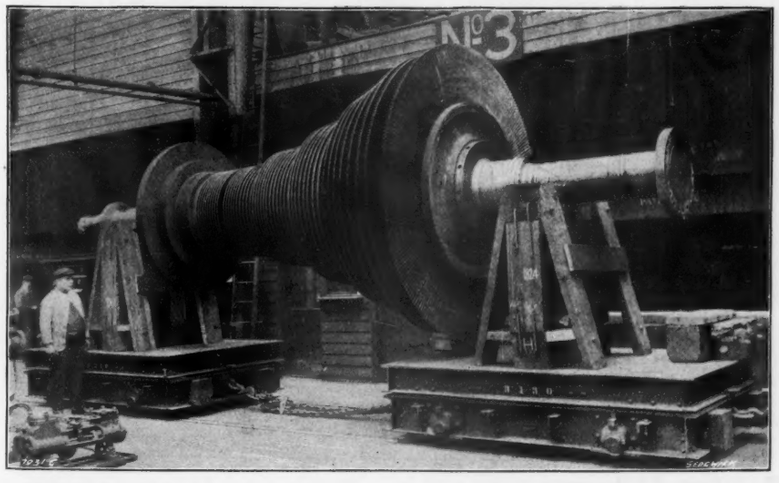

FIG. 3. ROTOR.

defined, propositions being subsequently submitted for ratification by the various nations concerned; a permanent international commission for the standardisation of aircraft materials and components should be set up; inquiries should be made of the postal authorities of European Governments as to the most suitable air transport time tables for the carriage of mails; that with reasonable flying hours, there is no evidence to show that pilots deteriorate physically more rapidly than men in other employments; that close relations should be established between all aerodynamic laboratories with a view to pooling and comparing of results; and that Governments should be asked to unite in subsidising trans-Continental air services.

After the chairman had declared the whole of the resolutions carried, he referred to the valuable nature of the papers discussed by the Congress and to the good to be anticipated from the personal contact of men of different nationalities, all of whom were interested in the development of aviation. He also expressed appreciation of the work of the organisers, mentioning particularly the Duke and Duchess of Sutherland, Major-General Sir F. H. Sykes, Lieutenant-Colonel M. O'Gorman, and Lieutenant-Colonel W. Lockwood Marsh. Finally he remarked that he understood that it had not yet been decided when the next Congress would be held, but it would probably take place in Brussels.

After a vote of thanks to Sir Samuel Hoare had been proposed by Major-General Sir F. H. Sykes and duly acknowledged, the meeting terminated. A number of members attended the Royal Air Force Pageant at Hendon in the afternoon, and the programme of the Congress concluded with an official banquet held at the Hotel Victoria in the evening.

20,000-KW. STEAM TURBINE FOR SHANGHAI.

As is now generally known the development of the municipal electricity undertaking at Shanghai, under the direction of Mr. T. H. U. Aldridge, has been phenomenal in character. In 1922, 232,000,000 units were sold and the load factor was 51·5 per cent. In this country the largest output at a municipal station was at Manchester, where it amounted in the same year to 158,000,000 units with a load factor of 21·6 per cent. During the war exceptional difficulties were met with at Shanghai since, whilst the demand was rising rapidly, new plant could not be obtained from Great Britain, and the German impulse turbines with which one station was mainly equipped proved to be defective both in the matter of design and of material, and gave constant trouble from repeated breaksdown. Two of these machines, indeed, developed serious blade troubles after only a few months' running, and further defects became prominent with further lapse of time. The cost of maintenance and repairs was, in fact, double that of the units at the other power station of the undertaking.

To cope with the steadily rising demand for current which is even now increasing at the rate of 25 per cent. per annum, two 20,000-kw. machines

DETAILS OF 20,000-KW. TURBO-ALTERNATOR FOR SHANGHAI.

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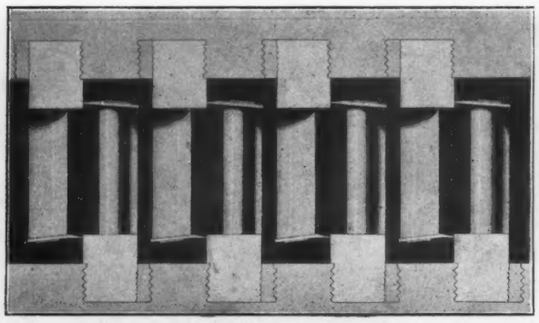


FIG. 8.

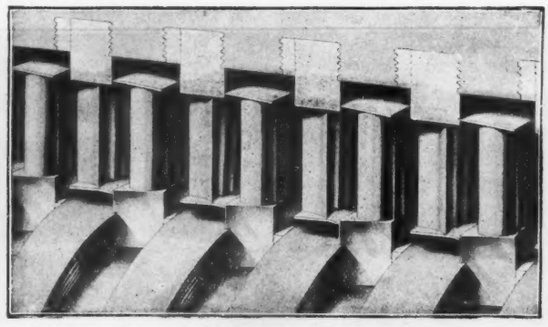


FIG. 9.

were ordered from British makers so soon as the conditions permitted, and we illustrate in Figs. 1 to 15 on pages 38, 39, the present page, pages 41 and 42, and Plate IV, the unit supplied by Messrs. C. A. Parsons & Co., Limited, of Newcastle-on-Tyne.

This turbine is designed to be operated with steam supplied to the stop valve at 180 lb. per square inch (gauge pressure), and at a temperature of 300 deg. C., which corresponds in this case to a superheat of about 192 deg. F., whilst the vacuum provided for is 28½ in.

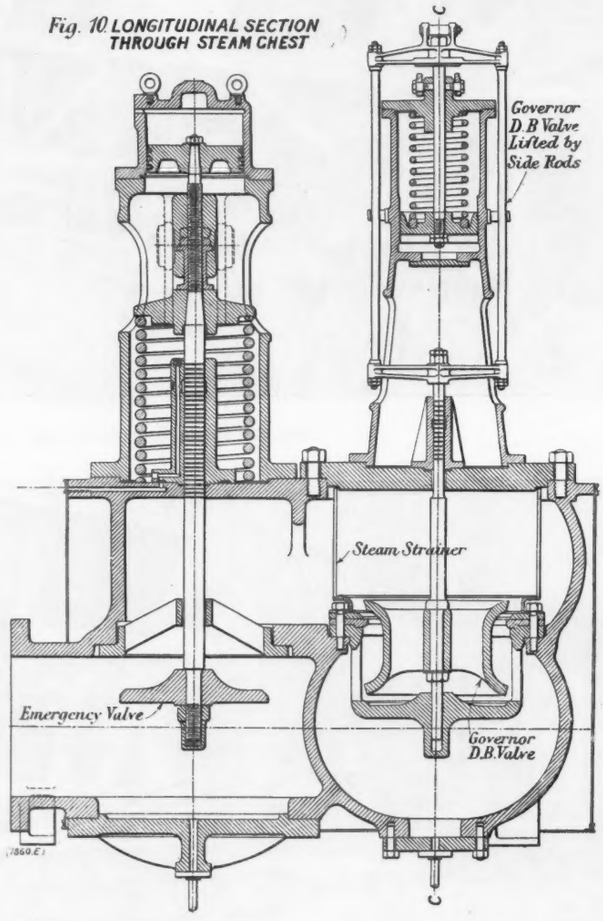
With these conditions the builders have guaranteed a steam rate of 11·35 lb. per kilowatt-hour, as measured at the switchboard. This corresponds to an overall efficiency ratio of 76·4, but from the data given by the drawings we shall be surprised if this guarantee is not very substantially bettered on trial. With the same nominal output as the unit supplied by the same builders to Chicago in 1912 (which at the date of its erection established a new high-water mark in regard to turbine performance), the Shanghai machine runs at double the speed, viz., 1,500 r.p.m., but nevertheless the relatively moderate vacuum specified, has made it practicable to use a single flow exhaust without incurring any serious penalty from inordinate leaving losses.

The blades of the last row are 22½ in. long, and are mounted on a disc 65 in. in diameter, so that the annulus available for the flow of the exhaust steam has an area of about 43 sq. ft., and the axial velocity of the steam on discharge will therefore as a maximum be under 600 ft. per second. Hence the leaving loss will be approximately 1·8 per cent. of the theoretical heat-drop.

From the longitudinal section of the turbine represented in Fig. 4, Plate IV, it will be seen that the turbine rotor consists for the most part of a solid steel forging, and that disc constructions are confined to the low-pressure end. These discs, it should be noted, abut together at their outer peripheries, thus obviating any possibility of the disc vibrations which have at times given rise to such serious accidents with turbines of a type involving the use of isolated discs. For the rest the blade speeds are moderate, the tip speed for the low-pressure blading being 740 ft. per second, and the mean speed some 590 ft. per second. The former figure may be compared with the blade tip speed of 1,000 ft. a second which was adopted for the last wheel of an exhaust turbine of the impulse type illustrated in our columns a few years ago. The turbine rotor completely finished and ready for putting in place on the casing is shown in Fig. 3, page 39.

The "end-tightening" method of combining low tip leakage losses with considerable radial clearances is used for all but the low-pressure blading. It was fully described and illustrated on page 211 of our issue of August 13, 1920. For the benefit of those still unfamiliar with this system, we reproduce from that issue Figs. 8 and 9, annexed. From these it will be seen that the leakage steam has to flow radially instead of axially, and the space open to it is adjustable by adjusting the position of the rotor in the same way and by the same operation as the dummy clearances are regulated.

Fig. 10 LONGITUDINAL SECTION THROUGH STEAM CHEST



The first row of high-pressure blading is 2 11/16 in. high and has a mean diameter of 35 11/16 in. A cross-section through the turbine at this region is represented in Fig. 5, Plate IV, which also shows the main steam inlet and the governor valve and its relay. Another section through this governor valve, and the emergency valve in series with it, is shown in Fig. 10, above. The spring shown above the emergency valve, tends to close it, and the valve is maintained in the open position by the pressure in the oil supply system, with which the cylinder shown above the valve is directly connected. Should the pressure of the oil fall either by a failure of the oil pumps or by the action of the emergency governor, the turbine is forthwith shut down by the automatic closing of this valve.

Provision is made for by-passing the steam for an overload but this by-pass is not being fitted at the outset, and presumably it is the intention of the purchasers to run this turbine at as nearly as possible at its point of maximum efficiency, taking overloads on other machines. A cross-section through the oil pumps and governor drive is shown in Fig. 6, where also, it will be seen that the oil discharged from the thrust block is delivered directly on to the worm gearing driving the governor shaft. The emergency governor is of the usual sliding-bolt type, and is fitted at the end of the turbine shaft as indicated to the left of Fig. 4. In all, the turbine has 48 rows of moving blades, and the value of the coefficient K is approximately 318,000, so that with the stated steam and vacuum conditions, the ratio of blade

20,000-KW. TURBO-ALTERNATOR.

CONSTRUCTED BY MESSRS. C. A. PARSONS AND CO., LIMITED, NEWCASTLE-ON-TYNE.

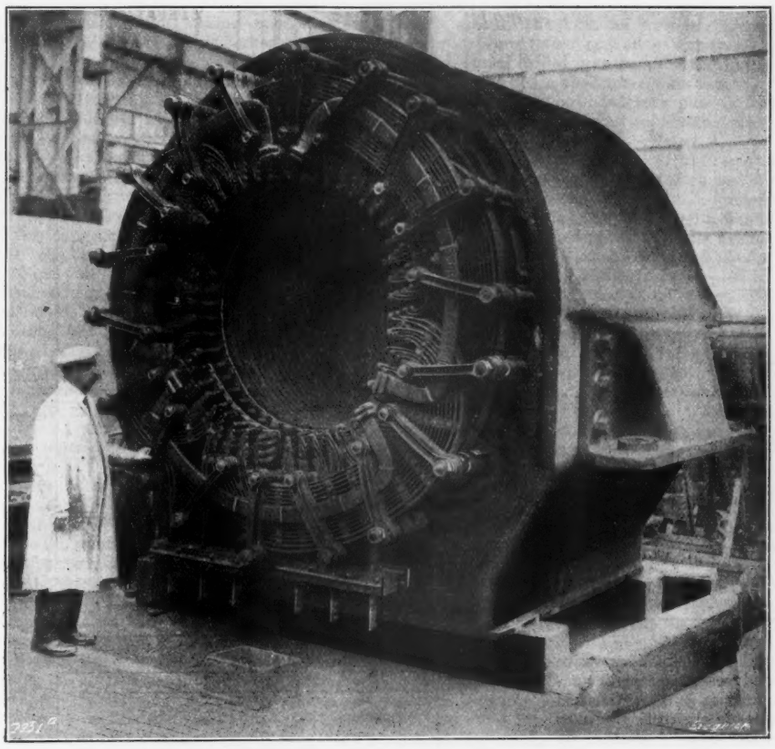


FIG. 11. STATOR OF ALTERNATOR.

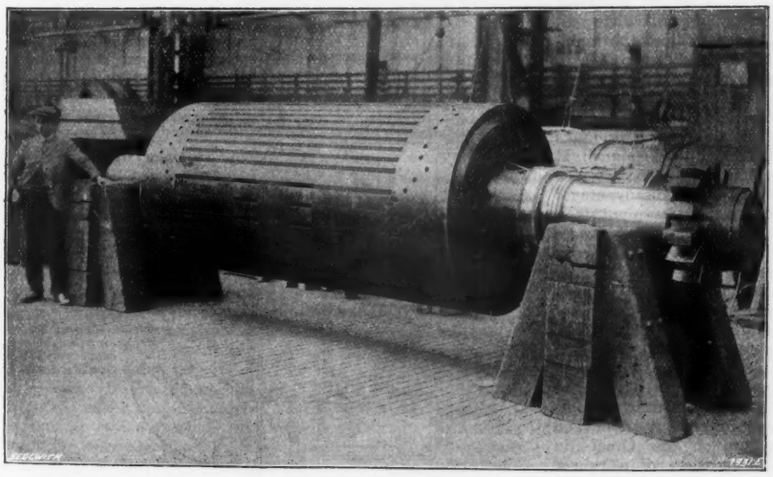


FIG. 12. ROTOR OF ALTERNATOR.

speed to steam (after correction for the effects of reheat and supersaturation) will on the average, be not far from 0·8.

A longitudinal section through the three-phase alternator is represented in Fig. 4, and a cross-section in Fig. 7. It is designed for a maximum continuous rating of 20,000 kw. at 0·8 power factor. The terminal voltage is 6,600 and the periodicity 50 cycles per second. The output is high considering the weight and dimensions of the machine, which it was found possible to transport by rail and ship complete, not merely with the core in position, but with the electrical windings also. The largest single part of the whole combined unit was the stator, which weighed 51 tons complete and, as stated, was built and wound complete before shipment. In this condition it is represented in Fig. 11, annexed. In spite of its compactness the high efficiency of 97 per cent. has been attained, a result largely due to certain special constructional and electrical features.

The stator core is supported at the outer ends by non-magnetic cast-iron plates and strong fingers of a non-magnetic alloy steel of great tensile strength. These fingers are sufficiently rigid to maintain the necessary pressure, and have enabled through bolts to be dispensed with. The core plates are of a special high-resistance alloy, thus reducing the iron losses. As shown in the cross-section, Fig. 7, Plate IV, the winding slots of the stator are completely enclosed, and consequently an air gap of moderate width is practicable without the production of ripples in the wave form of the voltage generated. The slot conductors consist of helically stranded coreless cable, which is not pressed to shape from a circular form, an operation with which there is some risk of damaging the insulation of individual wires, and no path is provided for eddy currents so that the heat generated is reduced to a minimum. Not only are the average temperatures low, but "hot spots" with local high temperatures have been absolutely avoided, a result which is largely due to the system of ventilation adopted by which cooling air enters and leaves at a number of separate ports, thus securing very uniform cooling.

Referring to Fig. 4 the air enters the machine at A, B, C, D and E. From these ports the air passes by radial vents to the air gap and, flowing along this, escapes by other radial vents into the exhaust chambers F, G, H, I.

Provision is also made for part of the air supply to flow through axial holes formed immediately behind the conductor slots, the proportions of these being such as to secure very uniform cooling. The stator end windings are cooled by blasts directed on to them from holes communicating with the end compartments A and E, and baffles are provided to distribute these air currents with maximum effect, each section of the end windings being individually cooled.

The rotor is mainly surface cooled, but in addition air is drawn in through holes such as are indicated at J in the rotor end caps, and additional air enters through idle slots such as those represented at K, Fig. 7, Plate IV. Gaps are left in the keys or cover-plates of these ventilating slots, as is best seen in Fig. 12, annexed, which shows the rotor complete.

The air circulation is arranged on the closed system, whereby the same air is used over and over again. This air is circulated through a closed path and cooled by a special surface cooler. This method was introduced on Parsons' machines in 1919, and has proved very satisfactory. Large external ducts are not required, and as the same air is used again and again there is no tendency for dirt to accumulate in the air ducts. Filters and washers are not required, and thus there is no danger of moisture being carried over into the alternator. A subsidiary advantage claimed for the system is that should a fire occur in the alternator the oxygen in the circulating air would be quickly used up and the fire consequently extinguished automatically.

The general arrangement of the air supply system as fitted at Shanghai is represented in Figs. 13 to 15, on page 42.

A motor-driven fan is provided at D, which forces the air through the duct A into the alternator and thence through the cooler C, which is incorporated in the foundation block. On leaving the cooler the air is drawn back into the fan through the suction branch E. The cooler is built in two sections, each of which is mounted on wheels running on guides grouted into the floor and provided with a T-bar at the top, the stalk of which slides between two guiding angle bars, fixed to the ceiling of the chamber, and which are best seen in Fig. 13. The valves V enable the corresponding section of the cooler C to be isolated and disconnected. With this provision the cooler can be inspected and cleaned without closing down the alternator, and either section can be completely withdrawn if desired. Doors are provided at F and G, Fig. 15, to facilitate inspection and, moreover, make it possible to run free air through the alternator in case of emergency.

The turbine and alternator were despatched to Shanghai from the Heaton Works (the air cooler following later) on November 10, 1922, in one train load of 550 tons gross, and were taken down to the North-Eastern Marine Engineering Company's works on the riverside, where the giant crane on their jetty was used for lifting the several parts on board the S.S. Radnorshire. The complete alternator stator, weighing 51 tons, was conveyed on a steel wagon specially designed and constructed by the London and North-Eastern Railway Company for

AIR-COOLING ARRANGEMENTS FOR 20,000-KW. TURBO-ALTERNATOR.

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Fig. 13. END ELEVATION.

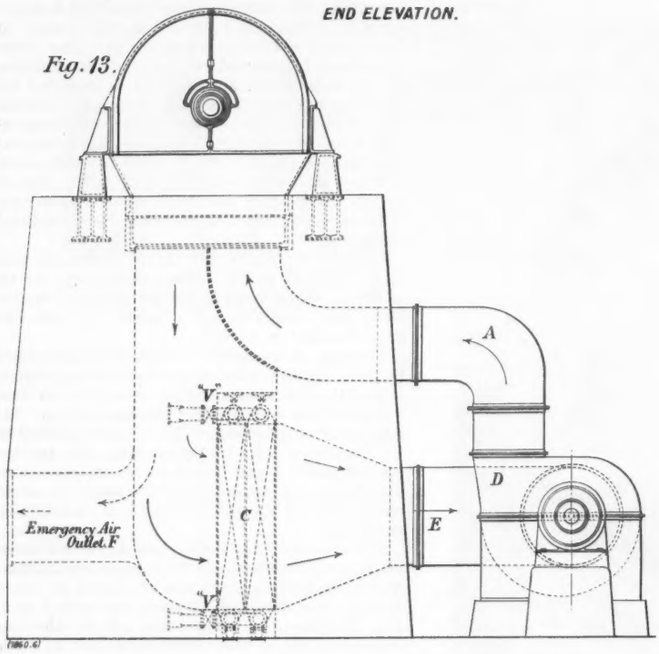


Fig. 14. ELEVATION.

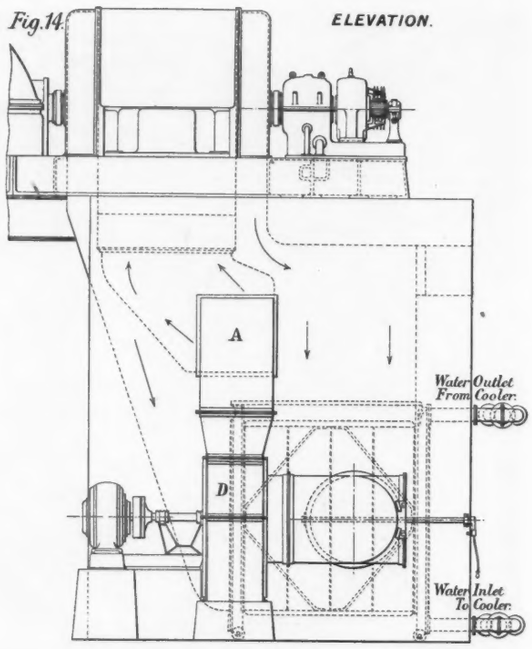
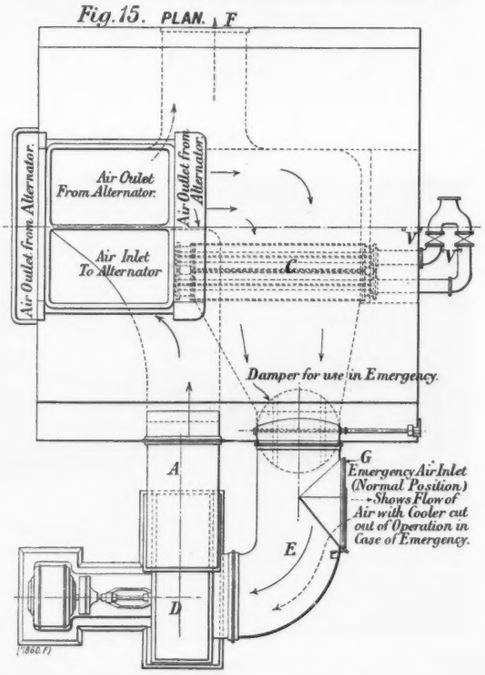


Fig. 15. PLAN. F



the purpose of transporting these heavy and bulky pieces. The ship arrived at Shanghai on January 26 last, and the erection of the new plant on site is now nearing completion.

THE INTERNATIONAL NAVIGATION CONGRESS.

(*Continued from page* 25.)

Locks and Elevators for Canals.

The second question to be considered by the Inland Navigation Section of the Congress was worded as follows: "Dispositions or arrangements to be adopted for locks, elevators, inclined planes and other means of overcoming differences of level with a view to facilitating the operations." Reports on this subject were received from representatives of eight countries, the general reporter being Mr. Sidney Preston, M.Inst.C.E. Mr. Preston reported that his subject could be divided into two sections, the first of which dealt with methods of overcoming differences in level in inland channels, the second with appliances facilitating movement at such points. The first section could be again divided into subsections dealing with locks, vertical elevators, and inclined lifts transporting the boats in floating tanks or on cradles. Actually, Mr. Preston presented his report under the latter classification, and summarised in turn the main points of the authors of the various reports. As a result of a scrutiny of the latter, Mr. Preston summed up the position to the effect that locks were still the best method of overcoming differences of level, especially where the lift was not great and the water supply ample. If the lift were considerable and the water supply deficient, lifts or inclines would probably prove more satisfactory. In the latter case, if the ground were steep and the boats less than 100 tons, a lift would be best. No really satisfactory system of transporting loaded cargo boats had been introduced. Expeditious locking was dependent upon suitable location and alignment of the locks, ample basins for waiting boats, ample sluices and conduits, with small openings into the lock to minimise local disturbance of the water, ample dimensions, good lighting at night. On the question of power-driven capstans a wide difference of opinion existed. The Denil method of reducing the velocity of water in reaches in which it is excessive was advocated in several communications. This method consists in obstructing the flow of water down a channel by means of a series of cills and pockets arranged something like a fish ladder, enabling boats to be worked up-stream in the way adopted with rapids.

The report from the representatives of Belgium MM. L. van Wetter and L. G. Schoentjes, dealt first with the seal required between the end of vertical lift elevator tanks and the high-level channel. It was pointed out that the wedge system had disadvantages owing to the stresses put upon the structure if operation were faulty, while it was not easy to arrange for slight variations in level required for different water levels. The pneumatic tube arrangement required air compressing plant, while the simple rubber-canvas strip or flap was not effective owing to insufficient pressure. The arrangement recently adopted on elevators on the Canal du Centre consists of a rubber gasket on a steel U-shaped movable frame. The frame is forced up against the tank by hydraulic pressure, the joint between the frame and the fixed structure being formed by rubber-coated canvas. The second section of this report dealt with the Denil method of working stretches of channel on steep gradients, already referred to, while the third was devoted to locks. In this connection recent locks on the Upper Scheldt were described, with their method of control from cabins, and the provision of electric towing capstans with guide rollers set at an angle of 60 deg. to the horizontal, in the lock wall coping.

Colonel E. A. Schulz reporting for the United States gave a *résumé* of recent canal construction in that country with brief particulars of a number of the more notable works. As regards construction all recent locks had been built in concrete; butterfly valves were giving way to sluice valves, Stoney gates and cylindrical valves. Needle and other types of movable dams were less often used and fixed dams more widely adopted. Mechanical towage was not employed. The most important locks of recent construction were the "Soo" locks (1,350 ft. long by 80 ft. wide), the Lake Washington Canal lock (825 ft. long and 25 ft. wide). The highest single lift was at Keokuk (40·3 ft.). It is impossible to summarise the section of Colonel Schulz's report dealing with individual works, and no indications of general tendencies

were given by the author except those referred to above.

The French report submitted by MM. Tumerelle and Deval, laid stress on the importance of expeditious manœuvring into and out of locks, as boat movements occupied by far the greater part of the time consumed in locking vessels through. In cases in which times were checked on the Canal du Centre, boat movements occupied 30·2 minutes out of a total of 38·05 minutes for a double locking, the closing of the gates and filling, &c., occupying the small balance. It was pointed out that by shifting the centre of the lock to one side, relatively to the line of the canal, a basin is formed in which boats could wait their turn close to the gates, when less manœuvring was necessary, the leaving boat soon being on its direct course. With double locks the provision of a long party division or midfeather of piling at each end of the locks prevented disturbance of the water, and so facilitated the working of boats into or out of one lock regardless of operations in the other. The electric capstan was useful but not a thoroughly practical solution of the towing problem at locks. It was useful in working the last boats of convoys into locks, but its operation was expensive. Electrical operation of valves and gates at large locks reduced the time of operation and also the staff necessary.

Three separate reports were presented for Great Britain. The first, by Mr. C. E. W. Cruttwell, in connection with locks pointed out how the time taken in locking boats through affected traffic movements and the spacing of locks. If this spacing were too short relatively to the locking time serious delay was bound to occur, which could only be reduced if twin locks were adopted. Water was unfortunately scarce where deep locks were required and more plentiful where lower lifts sufficed. If water was scarce and the lift in a short distance considerable, lifts or inclines might be adopted with advantage. As regards lifts the hydraulic ram system or the well-float system both required deep wells which were difficult to maintain. The electric system with wire ropes had advantages, but it was doubtful if it could be applied to heavy boats. As regards inclines the grade should not be steeper than 1 in 8. An incline to raise a boat 100 ft. was comparatively little more costly than one to raise it 50 ft. A lift or incline commonly effected a saving of 90 per cent. of the water required for locking. Generally the capacity of a single lift or incline was nearly the same as for a flight of locks, and of a balanced lift or incline about that of twin locks, but usually much cheaper than the latter to construct.

The second British report by Colonel J. A. Saner laid stress on adequate protection of the lock gates from injury, and recommended the operation of sluices by electric power. Colonel Saner was not in favour of prolonging the party division or midfeather above and below twin locks, but of extending the wing walls. For closing the gates high-pressure hydraulic power was best, but low-pressure turbines had been used satisfactorily. Elevators were serviceable where water was short and the lift high. At Anderton the lift worked satisfactorily, but skilled labour was necessary.

The remaining British report was by Mr. G. J. Griffiths, who dealt with locks on the Thames, and gave particulars of the methods adopted in reconstruction. He also described in some detail the conveyors used at Boulter's Lock for punts and light rowing boats, loaded.

The Italian report, presented by Sig. Luigi Gasparini, did not embody any discussion of the relative advantages of locks, lifts, &c., but described in detail the important locks on the new navigable waterway from Venice to the Po. These included the Brondolo Lock and the Cavanella d'Adige Lock. At the latter there is a syphon carrying the Adige under the lock floor.

The features adopted in the case of the new Meuse-Waal Canal form the chief subject of the Netherlands report submitted by Dr. L. Wentholt. This report again lays stress on the effect of the approaches upon the time taken in lockages. It recommended that sufficient water area be allowed at entrances for waiting barges to berth at one side of the lock centre line so as to allow the leaving boat to continue on a straight course and the entering vessel to swing into line with as little movement as possible. Approach walls could be built too rigidly—some elasticity was desirable in them. Reinforced concrete had been used for dolphins. The arrangement of auxiliary culverts should be such as to give as uniform flow over the whole area of the lock, as possible. Electric or power capstans were not altogether satisfactory. They required skilled operators and moving vessels into locks by them took more time than by tugs. Lock walls should be fitted with pins or bars for use with boathooks. Effective lighting was most important.

The most interesting feature of the report from Sweden, drawn up by Mr. S. Vinberg and Mr. L. Lawski, was the account given of the development of a new type of lock gate. Lifts and inclines have not been adopted in Sweden. On the Trollhättan Canal where the lift is considerable and the foundations are good, mitreing gates were adopted for the locks. An examination was made of various types of such gates and led to the conclusion that the most economical type of gate for the conditions to be met was the girder type gate with horizontal main girders and without vertical stiffeners. The operating gear adopted was a modification of the Panama Canal gear. A safety chain was adopted, hauled in by a motor and when taut automatically coupled up to a heavy counterweight, so that while offering a considerable resistance to a vessel striking it, the chain could be paid out during retardation. The new type of gate referred to has been adopted on the Södertälje Canal, and also on the Hammarby Canal, both under construction. This gate takes the form of a sector of a cylinder, two such sectors meeting like mitre gates in the centre of the lock when closed, and being withdrawn into recesses when open. The recesses are specially designed to sweeping curves (in plan), and no sluices or conduits are employed. The water is raised or lowered by opening the gates, when water at once flows between the two, and also behind each leaf or sector round the recess and into the channel beyond the gates. The issuing streams are directed across the lock, meeting together in the centre, where they are joined by the stream issuing between the gates. The result is said to be an almost entire elimination of disturbance. The gates open at first very slowly; afterwards the speed increases so that as the head decreases the opening rapidly increases. In view of the elimination of conduits and sluices this type of gate works out cheaper than the ordinary design, while the operating time is reduced and the capacity of the canal increased.

The report by M. A. Klir, for Czecho-Slovakia, is concerned chiefly with various proposals which have been made, but not yet decided upon. The value of the water resources of the country for hydro-electric development made it imperative that this should be considered at the same time as navigation. M. Klir's report dealt with projects for overcoming differences of level, in two sections. In the first he was concerned with systems which consume water, and in the second with schemes which do not involve the consumption of water, such as transporter railways for trains of barges or timber rafts. In the first section reference was again made to the method of retarding the flow in a steep channel by ridges and baffles projecting inwards from the sides and bottom. This type of channel, has been in use on the Elbe in Bohemia since 1912.

The discussion of this question, which was conducted in the afternoon of Tuesday, the 3rd inst. and the morning of Wednesday, the 4th inst., turned to a considerable extent on the conclusions embodied in Mr. Preston's report. It was suggested that some of them were outside the reference of the question and that others had been disposed of in connection with reports presented to earlier Congresses. Matters of this kind are of domestic interest to those taking part in these congresses, but are hardly of such a directly informative nature that it is necessary for us to reproduce them. Various technical matters were, however, raised in the course of the discussion, and to some of these we may refer. Colonel Saner referred to the question of protecting lock gates from injury owing to boats running into them, which he dealt with in his paper and which is referred to above. He was of opinion that chains should be arranged on the up-stream side of gates to help to take the shock in the event of their being run into. The chains were attached to the lock wall at each side and hung loose when the gates were open. In connection with the lift at Anderton he would say that the original hydraulic rams only lasted about fifteen years, and the lift was now slung and operated by electric power. He was of opinion that 350 ton vessels could be handled in lifts of similar type. With regard to capstans and similar appliances at locks it appeared in general that as boats must have some method of propulsion that method might well be used to move them in and out of locks.

Dr. L. R. Wentholt, of Holland, said that he had never found any necessity for the protection of lock gates, he agreed, however, with Colonel Saner that the best means of propulsion which could be used in a lock was the means of propulsion existing on the boats. Capstans were provided on some of the large locks in Holland, but they were never used. Colonel J. C. Oakes, of the United States Army, said that on the barge canals of the United States on which boats carrying from 1,000 tons to 2,000 tons were used, the boat power was used in passing through the locks. In one case a lock was provided with an electric locomotive, but it was never used. The barges were handled by tugs, 12 in a batch through the locks, and as many as 65 had passed down in canal with one tug. He knew no case of chain protection for lock gates on any of the barge canals, but the gates of a big lock at Louisville had been constructed with vertical framing and a heavy horizontal top girder, which it was considered was strong enough to resist any blow the gates were likely to receive. A heavy locking device joined the two horizontal girders of the two gates when they were closed. Mr. G. L. Griffiths, engineer of the Thames Conservancy, said that no efficient substitute had in general been found for locks, although conservation of water was in many cases an important question. For moving boats in and out of locks he thought the order of efficiency of the three common methods was the boats own power, then tugs and capstans last of all. Locks should, be placed as far away from side streams as possible in order to get favourable conditions for entering and leaving. On the Thames many locks had been built close to the weirs.

The various conclusions which it was proposed the section should come to on the matter under discussion were read to the meeting on the Wednesday morning and a long and somewhat desultory discussion took place on them, many members thinking that various special points were not given sufficient prominence. Finally a set of six conclusions were agreed to. It is not necessary that we should reproduce these *in extenso*, but we may indicate the points they covered. It was suggested that a lay-by provided with guides and of sufficient capacity to hold all the boats to be passed through at one locking should be arranged at each lock head. A sufficiently large relation between the respective water sections of the lock entrance and the boats should be adopted and a sufficient excess of available area of the lock chamber over the train marshalled for locking. It was also concluded that the means of traction through locks required further investigation and that special regard should be paid to locks of high fall. The wish was expressed that the Permanent Commission of Navigation Congresses should submit for consideration at the next Congress, the problem of overcoming great differences of level, especially in those cases where water levels vary.

Ship and Port Equipment for Loading and Discharging.

The third question considered by Section II of the Congress had reference to the equipment necessary for loading and discharging cargoes. It was worded "The Relative Advantages of Ship Equipment and Port Equipment for Loading and Discharging ships. Mechanical Equipment of Ports. Mechanical Handling of Freight. Loading, Discharging and Carrying between Ships and the various Depositing Points whether Covered by Sheds or Not." The general report on this question was drawn up by Mr. H. J. Deane, who pointed out that the first sentence could be considered by itself. His conclu-

sions were framed accordingly, but since his summary was made for 11 individual reports it was natural that he was not able to find unanimity on all points. His general conclusions embraced the point that prevailing conditions must decide whether equipment was to be provided on the ship or at port. For liners plying between definite ports much of the cargo handling gear could be dispensed with on board, adequate provision on shore being preferable. For cargo steamers and steamers not working fixed routes equipment on board was essential. The ship must be able to meet the conditions of the worst equipped port at which it might call. At ports where cargo was discharged overside in mid-stream sufficient cranes would be required to handle the cargoes from the lighters on to the quay. In the case of bulk freight, coal, grain, &c., special shore equipment served the purpose best.

On the remaining points the reports covered a very wide field so that it had been found difficult to give adequate summaries. Mr. Deane concluded that in the first place mechanical equipment should everywhere be given preference over extending manual labour. Electric power was preferable to steam or hydraulic power. Bulk cargoes and consignments in parcels of uniform size lent themselves to mechanical handling. Large fixed cranes and sheer legs were giving place to floating cranes. Electric trucking was advantageous except where distances were short and labour cheap. Railway lines in front of quay sheds were only desirable where it was possible to discharge direct into railway wagons.

The Spanish report, presented by M. de Castro, considered that the advantage of ship equipment was that a vessel was independent and could quickly commence to discharge overside into lighters or on to the quay, with possibly more expeditious working when special need arose, as, for instance, sailing at a particular time. Special shore equipment was best for loading coal. Heavy loads were best handled by shore equipment, as also were awkward goods such as rails, &c. Otherwise for miscellaneous cargoes ship and shore equipment were of about equal value.

The report for France was divided into two. The first part was by MM. J. de Pelissot and J. Alexis; the second by M. P. Barrillon. The former dealt with general merchandise and the latter with heavy goods. MM. de. Pelissot and Alexis stated that the war was responsible for great developments in port equipment. For general merchandise ample quay cranes of 1½ tons capacity were best, and reliance should not be placed upon ship equipment except when the quay cranes were insufficient in number. It was of little value to have cranes of various capacities—say, one crane in every four, of greater power—for the larger crane was seldom where it happened to be required. If a particular commodity was handled in quantity at a port, this traffic would be increased by the use of special equipment.

M. Barrillon's contribution dealing with heavy materials reviewed a number of installations made at French ports during and since the war. The capacity of cranes at ports showed a tendency to increase. For heavy goods, where there was much transhipment, pontoon cranes had increased the speed of working. Six separate reports were submitted for Great Britain, these being by Dr. Brysson Cunningham, Mr. A. R. T. Woods, Mr. E. Buckton, Mr. S. H. Ellis, Mr. H. G. Mitchell and Mr. T. A. Peace.

Dr. Brysson Cunningham considered that if cargoes were homogeneous, elevators and conveyors were the best plant for handling them. Otherwise the most expeditious method was the use of ships' booms and derricks, supplemented if necessary by quay cranes. By means of "burtoning" 40 to 50 drafts could be handled per hour, but the system required a special construction of shed. Burtoning appeared to be rather quicker than crane work, but cranes were more powerful.

Mr. Woods reported that Atlantic liners carried an altogether unnecessary amount of gear. Its reduction would decrease capital cost. The tramp steamer had to be made to suit any port where there was sufficient water for her and the tendency was to increase cargo-handling gear in such cases. Derricks and winches accounted for 5 per cent. of the capital cost of a ship, but the cargo capacity was not reduced by even 1 per cent. by their provision. When a liner had exceeded her useful life in the work for which she was built she became a general cargo boat, and then handling appliances were essential. Delays were not as a rule due to lack of adequate handling equipment either on the quays or the ships, but to the failure to remove goods from the wharves when landed.

Mr. E. Buckton's report stated that standardisation was impossible as conditions at ports varied so greatly. Ships derricks were cheap, but their use was limited. Quay cranes, however, to work modern vessels had to be large, and were therefore costly. Costs could seldom be recovered by hire charges. As at so many ports reliance had to be placed on ship equipment he was in favour of developments in that direction.

The report submitted by Mr. S. H. Ellis stated that for special cargoes the chief dependence had to be placed upon the shore equipment, but for general cargo, ships should be made independent of port appliances as far as possible. Floating cranes greatly expedited port work. Mr. Ellis quoted a rate of discharge of 125 tons per hour for 3,316 tons, for a ship equipped with one 45-ton derrick, four 15 ton and four 10-ton derricks and fifteen 2-ton winches.

Mr. Mitchell pointed out that the advantage of ship equipment was that it enabled both sides of the vessel to be worked at once, while if heavy loads were handled by the ship's gear it was always stowed in the hold so served, and thus could be as easily unloaded subsequently. Disadvantages of ship's gear arose in case of breakdown which suspended work, whereas with shore equipment a standby could be moved up to take the place of a disabled crane. Ships gear did not have much reach overside, whereas a quay crane plumbing a hold could set down anywhere within a considerable radius. So far as lifting out of the hold was concerned there was little to choose between modern equipment of both classes. Ship's gear was of little use by itself in ports where quay sheds were of more than one storey. If time permitted a vessel would find it economical to use her own gear rather than pay for crane by hire.

The report by Mr. T. A. Peace concluded that the general tendency of ports to spend large sums on equipment indicated that that type of gear was thought to be necessary. Generally ships' equipment was of only secondary importance, but in foreign ports it was often necessary to rely mainly upon it.

In the Italian report, M. A. Albertazzi considered that ship equipment could not rival shore equipment, though the former was essential in vessels trading to ill-equipped ports. An understanding between port authorities and shipowners as to the relative spheres of the two classes of equipment was desirable. M. Albertazzi considered that cranes on board ships had advantages over derricks as regards working, though cranes were more cumbersome and their motors could not be used like derrick winches for warping, &c.

The report by MM. H. de Roode and J. Sprenger of Holland argued that ships' gear was inferior to quay equipment, and even to floating discharging plant. The Burton system was criticised on account of fuel consumption and wear and tear, as well as for the additional labour said to be required when compared with electric quay cranes. This report described a number of special appliances such as floating cranes, transporter cranes, floating grain elevators and coaling elevators, bucket elevator unloaders, &c., mainly developed at Rotterdam.

On the second part of the subject the reports are too diverse for a real summary to be practicable. The Spanish representative, M. de Castro reported in favour of mechanical handling wherever possible, and a reduction of manual or animal labour. Cranes should be of 2 tons to 4 tons capacity, with 36 ft. reach beyond the quayside. Electric power was the most convenient; it should be taken from the ports own supply station. Ports should have their own locomotives and special wagons in order to avoid delays and the accumulation of freight.

MM. de Pelissot and Alexis stated that port equipment had not kept pace with the increase in tonnage and speed of ships. Everything should be done to increase the tonnage handled per running metre of quay, in order to prevent avoidable extension. Quay cranes varied from 3 tons to 5 tons in capacity, some running up to 7 tons. Floating equipment ran up to 90 tons capacity. In discussing the handling of goods this report referred to many recent installations at French ports, including the Bordeaux-Bassens grain elevating and conveying plant described in ENGINEERING some time ago.* M. Barrillon's section of the French report was mainly concerned with the handling of coal traffic at French ports, including short descriptions of the plant at Rouen, Donges, and the new port on the Caronte, &c. For electric cranes commutating alternating-current motors had been found to give good results. With regard to transporters whatever the speed of the trolley the cycle was mainly governed by the distance to be covered. For long distances aerial transporters were to be preferred.

The English reports covered various points. Dr. Brysson Cunningham suggested that greater uniformity in the size of package would be an advantage and containers might be introduced to attain this in the case of small parcels. Mr. Woods pointed out that a ship only earned money while moving and that everything should be done to increase the ratio of useful to total time. Mr. Buckton gave illustrations of three arrangements of wharfage, including one in which the shed was close enough to the quay side to make it possible to land goods by the ships' gear on to an upper storey of the shed. Mr. Ellis gave a great deal of information regarding ports in the East and concluded by recommending for handling cargo *ex* passenger ships a transporter type of crane with an arm capable of being lowered so as to extend out over the vessel berthed. Mr. Mitchell discussed various types of cranes, preferring electricity to hydraulic power, and 3-ton quick-luffing portal cranes to other types. Mr. Peace advocated the use of electric trucking for transferring cargo from the ship's side to the shed, with ample railway accommodation both at the back and front of sheds. He also dealt with special installations for handling bananas and frozen meat.

In the Italian report M. Albertazzi advocated the supersession of hydraulic plant by a combined electro-hydraulic system in which electric power was supplied to the portable plant on which the conversion was made to hydraulic power. At Genoa electric driving was adopted for the hydraulic pumps of the central plant, owing to the price of coal. In order to overcome the variation in demand a system of double pumps was adopted in which the motor speed was kept constant, but the delivery varied. This was accomplished by connecting the cylinders in pairs, one on each pump, and introducing an epicyclic gear by means of which the pump phases could be varied. It was thus possible to make both pumps draw at the same time (giving maximum delivery) or to make one cylinder draw while the other was being discharged, thus producing a neutralising effect with delivery nil.

The floating equipment, the description of which formed a feature of the report for Holland by MM. de Roode and Sprenger, has been referred to above. The main portion of the Swedish report presented by MM. A. Lundberg and W. Davidsson was devoted to descriptions of various types of cranes. These included a floating crane of 61 tons capacity capable of moving along a track 32 m. in length on its pontoon, the track gauge being 13 m., the possible movement of the crane being 9½ m. The maximum radius of the jib was 18½ m. In the case of a number of other cranes, of the portal or semi-portal type, the crane was arranged to traverse on the lower structure to and from the quay side and sheds. The lifting capacity of cranes for general quay work was about 2·5 tons with cranes of 5-tons' capacity at intervals.

The discussion on this question was held on Wednesday morning, the 4th inst. Dr. Brysson Cunningham illustrated his communication by means of a number of lantern slides depicting cargo-

* See vol. cxii, p. 312.

handling equipment on ships and at docks, dealing with all classes of goods. Many members criticised the suggestions put forward and contradictory views were common. After an ample opportunity had been afforded for the expression of opinions, the chairman stated that the varied character of the comments was due to the fact that few ports resembled each other in the class of cargo they handled, and there were essential differences in the equipment of ports where loading was done from those at which unloading was the common operation. A sub-committee was appointed to consider the whole question and asked to submit at the next meeting, suggestions for a resolution.

When the proceedings were resumed on Thursday morning the chairman called attention to the fact that objection had been raised to the form of the resolution on the depth of docks and draught of ships. An intimation was made, that so far as the Suez Canal was concerned, increased depth would be provided should it be necessary to meet the requirements of new shipping and the resolution was modified to put it into an acceptable form.

The discussion on Question 3 was then resumed, and as some of the speakers expressed the view that ship equipment was necessary for cargo-handling in emergencies and in altering the positions of the cargo, Mr. H. J. Deane suggested that emergency matters should not be dealt with in the discussion as they could only be considered in relation to the route of the ship. The provisions to meet them were matters solely for the decisions of the ship constructors, owners and concerns like Lloyds. Finally a general resolution expressing the view that port equipment was to be preferred was passed.

On the second part of the question it was decided that the mechanical equipment at ports for handling freights was of such a varied character as not to admit of definition in general terms. It was evident that when mechanical equipment could be economically, installed, it should be done, as it led to quicker and more economical handling of goods. The details of the equipment must depend on the needs and the possibilities of the trade.

RAINFALL AND THE FLOW OF RIVERS.

IN addition to the "questions" on which the Congress was expected to come to definite conclusions for transmision to the permanent commission, various "communications" were also discussed. These concerned matters of general interest bearing on inland or ocean navigation, but on which it was evidently considered premature or difficult to come to formal conclusions. The broad nature of the questions dealt with under the head of communications is well illustrated by the first communication brought before the Inland Navigation Section. It was: "The Influence of Surface Waters and Subterranean Sheets of Water on the Flow of Rivers; Regime of Mixed Canals; Estimation of the Water Consumed for Navigation and Irrigation Uses; the Portion returned to the Subterranean Sheet of Water."

The general reporter on this question was Mr. Edward Sandeman and seven papers were submitted bearing on it. In his report Mr. Sandeman pointed out that the relation between the rainfall on a watershed and the measurable flow-off in the stream draining the shed was one that admitted of no general solution which could be universally applied. The percentage of measurable run-off might vary from zero to 90 per cent. or even higher. In addition to the total annual run-off and the mean annual run-off, the actually recorded or the probable maximum and minimum were of importance. The latter would be the lowest discharge of the stream after a long period of dry weather and would be entirely due to the yield of subterranean water. On small areas of impervious surface this minimum might reach to limit of zero, but from watersheds of a few thousand acres and over and having a fair percentage of previous surface strata, a limit of 0·2 to 0·3 cubic feet per second per 1,000 acres would be a probable figure, but as much as 0·5 ft. per second was not unusual. The maximum-discharge would depend upon combined conditions of extremely heavy rainfall and a saturated or snow covered watershed having favourable geological conditions. The discharge per unit of area would, in general, vary in inverse proportion to the area of the watershed. The following figures had been recorded:—

	Maximum Discharge in Cub. Ft. per Sec. per acre.
In Great Britain, on mountain area of 7,000 acres with moderate mean rainfall	0·50
In Great Britain, on low-lying watershed of 2,400,000 acres	0·015
In India, on mountain area of 33,600 acres with high rainfall	1·00
In America, on 119,000 acres (California)	0·15

In Great Britain the total losses by evaporation and percolation, which were usually expressed as equivalent to so many inches of rain on the watershed, ranged generally from about 10 in. to 18 in. per annum, but considerably higher figures had been recorded in some cases. Ordinarily the losses on moorland watersheds varied from about 20 per cent. to 30 per cent. above to 20 per cent. or 30 per cent. below the mean where records were based on stream flow, but in cases where the water was stored in impounding reservoirs the recorded variations were very much greater in some instances owing in all probability to the subterranean storing of water in pervious formations beyond the margins of the reservoirs. The losses by evaporation, absorption and percolation varied with the rainfall, being at a maximum in years of high rainfall and at a minimum in years of low rainfall. In estimating the probable annual yield of a watershed, the average evaporation losses were deducted from the total annual rainfall and the balance considered as to run-off. With total rainfalls ranging from 22 in. to 100 in. per annum to deduction of the losses of 10 in. to 18 in. would give 18 per cent. to 90 per cent. of the rainfall available. The matter was, however, so dependent on local conditions that it was difficult to lay down any rule to express the relation.

In navigation canals the total consumption of water would be divided between that used at the locks, losses from evaporation and percolation, leakage from locks, &c. These being local factors no general estimate was possible. The following figures which had been obtained regarding the evaporation from water surfaces in several countries might, however, be quoted:—

Great Britain—average per day 0·035 in. to 0·06 in. in depth.
France—average per day 0·05 in. to 0·097 in. in depth.
India—average per day 0·10 in. to 0·30 in. in depth.

The quantity of water consumed in irrigation would vary according to the nature of the crops, the soil, climate, &c., from 10 in. to 30 in. per season. A flow of 1 cub. ft. per second would usually irrigate from 100 acres to 200 acres, but in the case of certain crops requiring exceptional quantities of water, the figure of 100 acres would not be reached. To the water actually irrigated on the land there required to be added the losses in the distributing canals in order to obtain the quantity required at the head of the canal. These losses varied with climatic conditions, the nature and size of the canal and the manner of constructing it. Evaporation would be approximately the same as in a navigation canal, but losses from percolation would probably be higher, as in the navigation canal more care would probably be taken to render the work watertight. Although not strictly accurate it was the ordinary practice to express the losses in irrigation canals as a percentage per mile of canal of the flow entering at the head. On that basis the following examples of total losses had been recorded:—

India 0·2 to 0·3 per cent. per mile.
Italy 0·05 per cent. per mile.

In America and South Africa some much higher losses had been measured. The loss naturally varied with the nature of the ground through which the canal was made, and also with the discharge. The smaller the discharge usually the greater the percentage of loss. In the Punjab it had been found that the losses from evaporation and absorption amounted to 8 cub. ft. per second per 1,000,000 sq. ft. of wetted area in the main and branch canals.

It is not necessary that we should deal in any detail with the seven papers which were contributed in connection with this subject as Mr. Sandeman reviewed all the main aspects of the question in his general report which we have summarised. We may, however, indicate the nature of the various papers and quote any interesting figures. The first paper by Professor D. W. Mead of the University of Wisconsin and reviewed the geological, surface and meteorological conditions favourable to maximum and minimum run-off, regularity of stream flow, etc. The second paper by M. Dienert, chief water engineer of Paris, gave some figures for water supplies required in connection with navigation and irrigation canals. The supply required for a navigation canal, presumably in France was stated to be a daily volume of 6,000 + 1,000 N cub. metres for a canal 2·2 metres deep, 10 metres to 12 metres wide at the bottom and 18 metres to 21 metres wide at the water surface, N being the length of the canal in kilometres. The quantity of the water required for irrigation was given as 1 litre to 3 litres per second per hectare according to the nature of the soil, tillage, climate and crop, the water being used during a period of 180 days in the year. Evaporation from the surface of the water on the canal du Nivernais was stated to be 0·5 metre to 0·9 metre per annum, two-thirds of which was lost in summer and one-third in winter. A depth of 0·9 metre per annum represents 0·3 litre per second per hectare of which 0·2 litre per second might be counted as the loss during the period of irrigation. A crop of beetroots or maize was said to take about 50 cub. metres of water per hectare, and Hall was quoted as authority that 300 grammes of water are required for the production of 1 gramme of dry matter in a crop. As a mean for French irrigated areas, 300 cub. metres of water were required to produce 10 tons of plants harvested per hectare which equalled 0·2 litre per second per hectare for 180 days.

There were two papers from Great Britain, the first by Mr. de Carle S. Salter was chiefly concerned with rainfall observations and insisted on as the necessity for care and proper methods if accurate results were to be obtained. The second by Mr. H. A. Reed, chief engineer of the Manchester Ship Canal, gave data and deductions referring to the connection between rainfall and discharge from the River Mersey. The discharge was obtained from a weir over 200 ft. long over which the river flows near its confluence with the Manchester Ship Canal. The area of the catchment basin was 162,680 acres and there were 19 rainfall stations on it. The investigation was complicated by the fact that 19,300 acres of the basin of Longdendale which forms part of the watershed was set aside for the supply of Manchester and the water collected in reservoirs, 2,140 acres were also set apart for the supply of Oldham. Both of these towns were outside of the basin of the Mersey. Deducting these two areas left a net area of 141,240 acres or 220 sq. miles, the run-off from which ought ultimately to pass over the weir. In addition to the water abstracted by Manchester and Oldham a considerable quantity was used for domestic and trade supplies in the basin which had a population of 616,000 in 1921. Water was stored in various reservoirs for these purposes, and the dry weather flow of sewage effluent returned to the river by 25 different authorities was estimated to amount to 21,560,000 gallons a day. In addition compensation water from the Longdendale reservoirs averaging 13,610,000 gallons a day had to be returned to the river making with the sewage a daily contribution of 35,170,000 gallons, equal to 65 cub. ft. per second. When the Longdendale reservoirs were overflowing, the surplus water went to the river in addition to the compensation water.

The lower portions of the catchment area from the weir to Stockport sloped gently up from 34 ft. to 300 ft. above sea level. The upper portion was steeper and very irregular rising to an average level of 1,800 ft. along the crest of the watershed with a maximum of 2,088 ft. at the peak. The average rainfall over the whole area in 1921 was 35·4 in. equal to 662·9 cub. ft. per second or 4·085 cub. ft. per second per 1,000 acres. The height of water over the weir was taken once daily and the average run-off at the weir was 365·7 cub. ft. per second, or

TWELVE-SPINDLE RAIL SLOT-DRILLING MACHINE.

CONSTRUCTED BY MESSRS. RICHARDSONS, WESTGARTH AND CO., LIMITED, ENGINEERS, MIDDLESBROUGH.

SECTION THRO TRAVERSE GEAR TABLE.

Fig. 1.

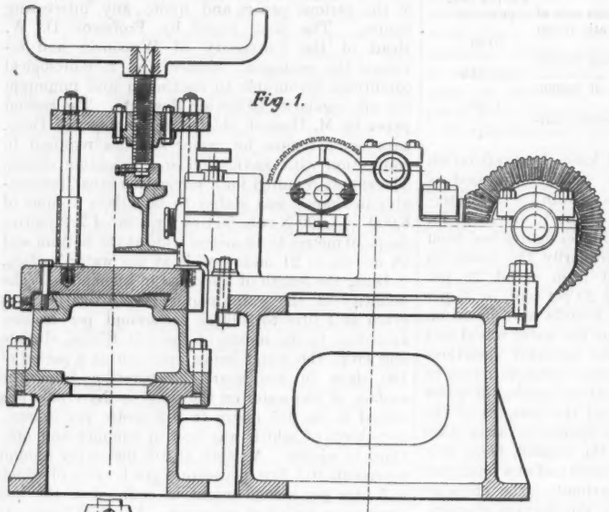


Fig. 2.

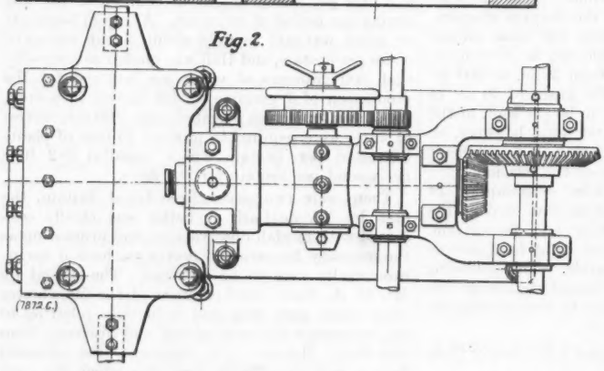


Fig. 3.

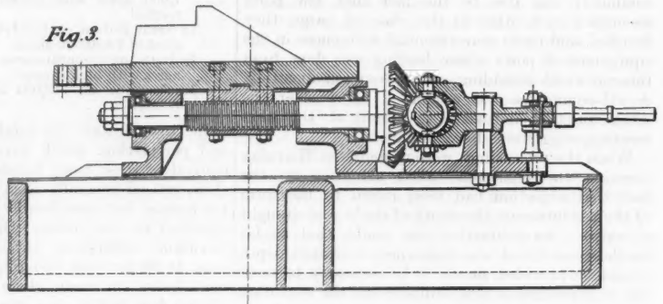
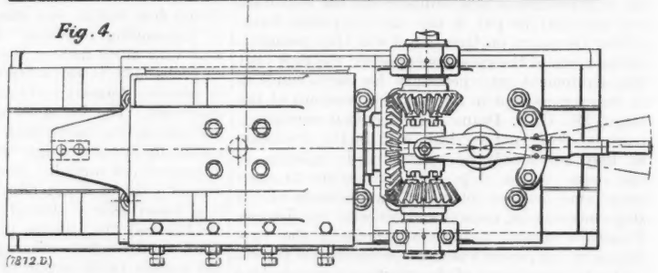


Fig. 4.



2·25 cub. ft. per second per 1,000 acres. The total run-off for the year, therefore amounted to 55·16 per cent. of the total rainfall. The minimum discharge for the year was on July 11 and amounted to 109 cub. ft. per second or 0·67 cub. ft. per second per 1,000 acres. This was after two months with very little rain and was attributed by Mr. Reed to underground water from the upper regions, the constant compensation water and fairly regular discharge from the industrial reservoirs and of sewage.

The next paper was by Mr. Axel Wallen, chief director of the Meteorological and Hydrographic service of Sweden, and described in some detail the method of collecting hydrographic data employed in that country. This was followed by two papers dealing with the River Elbe respectively written by M. J. K. Kobza, chief advisory engineer to the Ministry of Public Works, Prague, and M. A. Hengenius, advisory engineer to the Ministry of Agriculture, Prague. These papers gave details of the discharge of the river, of the size of barges which can navigate its various reaches and of projected improvements. They cannot be effectively summarised in a small space and would require maps for their proper presentation.

Mr. Sandeman in introducing his general report stated that it was unfortunate that engineers in England had to rely on private records for the rainfall data. Various methods of measurement and computation were used by different workers. The Government had many times been urged to set up an organisation to take charge of this work, but nothing had been done, and he suggested that the International Navigation Commission should set up a committee to standardise the method of taking records and interpreting them.

Mr. Sidney Preston said that very heavy losses from evaporation and absorption were experienced in connection with irrigation work in India, and in some cases only 25 per cent. of the water which was collected reached the field. Great difficulty had been experienced in obtaining any reliable data connecting rainfall and river flow, while the statistics available were far from reliable. Dr. L. R. Wentholt, Engineer of Ways and Communications at Nymegen, Holland, said the subject of the paper was of great importance in Holland since in the many parts of the country which were below sea level the water did not run off, but had to be pumped off. Very accurate statistics had been collected, and the percentage of rainfall which had to be pumped off an area of 80 sq. miles was distributed as follows throughout the year :—

	Per Cent.		Per Cent.
January ...	100	July	20
February ...	100	August ...	18
March ...	80	September ...	42
April	45	October ...	57
May	20	November ...	84
June	20	December ...	100

The land to which the records referred was of a rich agricultural nature.

Mr. Narciso Ping de la Bellacasa, of Madrid, said that in the central plateau of Spain the rainfall averaged 16 in. to 24 in. and that of this 25 per cent. to 50 per cent. was lost in evaporation. Automatic rain gauges had to be found necessary if accurate records were to be obtained. Mr. M. R. Ver Loren van Thermaat supported the idea that a uniform method of recording run-off, &c., should be introduced. The length of time of the rainfall in relation to the run-off was an important factor and should be introduced into any standardised method of recording. Too short a time should not be taken and periods of 30 days would probably not be too long. Mr. B. Howorth called attention to a book by Nathaniel Beardmore published seventy years ago and of which a copy was to be seen in the Institution of Civil Engineers' library. Beardmore estimated the average figure of visible run-off for Europe as one-half to two-thirds of the total rainfall. For the River Lea, Beardmore gave a figure of run-off of only one-quarter of the total rainfall, and records of fifty years had shown this estimate to be absolutely exact, which suggested that Beardmore's other estimate should be treated with respect. The River Lea ran largely over chalk beds, and the water was undoubtedly lost underground. Mr. G. J. Griffith, engineer to the Thames Conservancy, said that the records in existence for the Thames were probably the most complete in the world. The authority was under statutory obligation to keep such records in connection with the water supply to London. The information available allowed them and the Metropolitan Water Board to see fifty years ahead and to plan reservoir building in very adequate time. The river flow could be regulated at 47 weirs. The wells were now being tabulated and their depth of water recorded, and he hoped that in ten years full data would be available on the rate of flow of water underground. In parts of the area water did not flow into the river until from four to six months after it had fallen.

(To be continued.)

TWELVE-SPINDLE RAIL SLOT-DRILLING MACHINE.

A LARGE slot-drilling machine for dealing with tramway rails has recently been completed by Messrs. Richardsons, Westgarth and Co., Limited, of Middlesbrough, for the Cargo Fleet Iron Company, Limited. The original design of the machine was due to the latter company, but Messrs. Richardsons, Westgarth and Co. were responsible for several modifications, as a result of which co-operation a very serviceable tool has been produced suitable for heavy continuous service. It is illustrated on the present and opposite pages and on page 50, and is capable of slot-drilling 60-ft. rails at 12 points simultaneously, 12 drilling heads being provided, carried on longitudinal bedplates. One motor having a wide range of speed is situated at one end of the machine and works all operations. The rail to be slotted is held in a number of clamps shown in Figs. 1 and 2, while they are also to be seen on the near side of the machine in Fig. 8. These clamps, the construction of which is evident from our drawings, all slide on the long bed, and distance bars couple them together. Arranged on the bed between the clamps are a series of idler rollers carrying the rail to be drilled.

Arranged on another long cast-iron bedplate alongside are the 12 drilling heads. These are separately adjustable and can be clamped where required along the bed. All the heads are driven from one back shaft, by means of bevel gears. This shaft is shown clearly in Fig. 9. The drive from the 20 h.p. motor is through single reduction gear, the speed variation obtainable with the motor sufficing for all requirements. The backshaft motion is used for two other purposes. A short cross-shaft is driven off it, and this by means of dog clutches and bevels provides a reversing feed for the drills and also for the rail carriages. The feedshaft extends the whole length above the machine and is

TWELVE-SPINDLE RAIL SLOT-DRILLING MACHINE.

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Fig. 5.

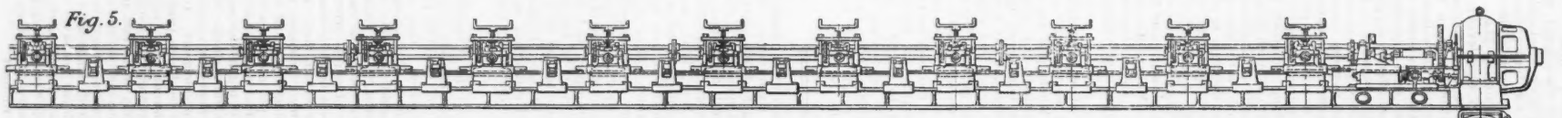


Fig. 7.

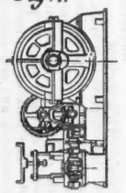
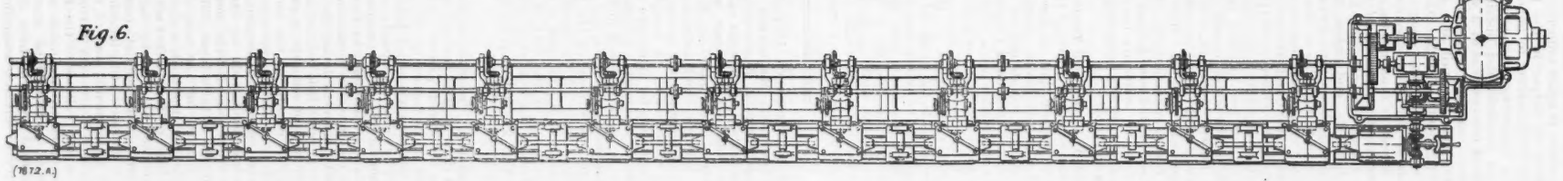


Fig. 6.



(7672.A.)

carried in bearings in the drilling heads or saddles. The feed is transmitted to the drill by the gears shown in Fig. 2, a hand-operated clamp being provided at each head, while the dog clutch at the driving end provides means of withdrawing the drills.

The second motion transmitted to the rail carriages also embraces bevels and a reversing dog clutch, as shown in Figs. 3 and 4. In these figures it will be seen that the bevels are shown meshing with a bevel on a short length of shaft part of which is screwed. This screw is fixed on the machine, but it is provided with a nut, which is fastened to the underside of a traversing table arranged to slide longitudinally on the bed of the machine. This table is connected with the nearest rail carriage by means of a short distance rod, as shown in Fig. 6.

The operation of the machine is as follows: After adjustments have been made and the rail clamped in position, the drills are started and the forward feed is thrown in. When the drills are through the rail, the traversing motion is thrown in and the rail carriages are all drawn to the right (in Fig. 6). When slotting is complete the drills are all backed out, the rail run out endwise and another inserted and clamped. The end of this rail is butted up against a cross-piece held by the shoulder of the brackets shown in Figs. 3 and 4, on the moving table, and for the next slotting operation the rail is pushed by these in the opposite direction. The slots can be drilled up to 6 in. length. The reversing gear makes the whole cycle of operations very expeditious.

NOTES ON NEW BOOKS.

IF all the books published on factory organisation and administration are read, the future of production as regards either volume or cost, should leave little to be desired. There are certainly no logical grounds why engineering works should remain badly organised if knowledge of principles and descriptions of what other people are doing have any value. Men who know, and, in fact, some who do not know, are doing their best to disseminate what knowledge they have, in the form of books, and the difficulty of the man in the street to-day, is not to find a book to suit his requirements but to decide upon one of many. The fact that the ground has been covered and recovered makes it difficult for new material to be presented, but the manner of presentation is being constantly improved, and books on this and kindred subjects are now quite well arranged. "*Practical Factory Administration*," by Matthew Porosky (McGraw-Hill Publishing Company, Limited, 6 and 8, Bouverie-street, London, E.C. 4; price 12*s.* 6*d.* net), is a book in which the treatment is at once comprehensive and satisfactory. In it, buildings and equipment, the handling of materials, the management of labour, wage systems, planning, records of production, and costs are discussed in such detail as 237 pages allow. A number of forms are reproduced and "typical questions" are put at the end of each chapter. The book is printed in quite readable type and on a quality of paper which makes its handling a greater pleasure than is the case with many other productions.

Dr. Josef Fritsche, of the German Technical High School of Prague, deals with statical problems in his "*Berechnung des symmetrischen Stockwerkrahmens*" (Berlin: Julius Springer; price 2*s.* 6*d.*). Literally translated the title of his volume of 90 pages is: Calculation of the symmetrical framing of several storeys with inclined or vertical pillars with the aid of differential equations. The point is that he discusses unbraced girder systems of the Vierendeel type, about the advantages of which over braced systems opinions differ. He does not enter into this controversy, nor does he question that mathematically a partial solution of the n linear equations with n unknown quantities of an indeterminate system, acceptable to engineers and architects, can frequently be found without much difficulty. But he suggests that the method of equations of linear differences and of recurrence formulæ, which he applies to these particular problems, will generally be more expeditious and preferable, because it yields a value for any desired moment without necessitating the determination of the intermediate values. The volume shows how such formulæ can be developed and explains their use by a few examples.

So many books have been written on the subject of costing that it might have been thought there would be neither justification nor room for another, but the latest to come to our hand appears to be an exception in this respect. "*Costing and Price-Fixing*," by J. M. Scott-Maxwell, B.Sc., M.I.E.E. (London: Sir Isaac Pitman and Sons, Limited, Parker-street, Kingsway, W.C. 2; price 6*s.* net), is somewhat different from most books on the subject, inasmuch as in it there is reflected the practical experience of an engineer, who is actively engaged in the direction and control of an engineering works, as against the more common position of an accountant writing on what is largely a technical question and, therefore, because of the lack of the necessary technical knowledge, more or less theoretically. In this connection, the author strikes the right note in saying that "the situation demands almost a new profession, namely, that of engineer-accountant—an expert with an engineer's training and an accountant's knowledge of book-keeping." Failing this dual experience at their disposal, many firms, even though they may have costing systems, will continue to manufacture blindly, their books giving cost figures which are not in accordance with the facts. "Some articles make too high a profit and carry those that make little, none at all, or even incur a loss." All aspects of costing and price-fixing are dealt with, both production and commercial. Under the heading of production cost, routine is discussed for the issue of manufacturing orders, the control and prime cost of material; wage systems and labour costs; and on-costs and their distribution. These matters are exhaustively dealt with, but we feel the value of the book lies not so much in the description of a costing system as in the reasons given and the arguments, for or against, the adoption of any particular policy. To describe a costing system has very little real value because, costing systems can so rarely be purchased "ready made." What matters most are the principles; the weaknesses of practice to be made plain; the pitfalls to be made clear, and much of the discussion is directed to this end. The treatment of the question of the distribution of oncosts is on sound lines. Examples are given which show the utter absurdity, from the standpoint of accuracy, of the percentage on wages method. There is a useful chapter on the building up of monthly prime cost statements for the purpose of arriving at an approximate idea as to the financial position more frequently than once a year. Sales on-costs are discussed together with the fixing of selling prices. In the chapter on wage systems, a warning is given with reference to the dangers of the "Priestman" system, concerning which the author states that "the system has a very limited application and has latent in it great possibility of serious economic trouble." In another direction, although not really a costing matter, we are sorry to note the author puts the question of inspection in a somewhat wrong perspective. "Inspectors . . . are absolutely essential in all works on piece-work or premium bonus or collective bonus." The position, as it appears to us, is that inspection is necessary, primarily because the skill and integrity of the individual workman cannot always be relied upon, rendering the laying down of a standard of workmanship necessary and supervision also, to ensure that the standard laid down is achieved and maintained. The standard of workmanship obtaining in some time-working shops is often of the lowest, owing to the wrong belief that inspection is not called for, for work done under the time system. In a foreword, Lord Weir says "there are many questions in regard to industrial economics which are now dealt with as matters of opinion, while much more properly they could be regarded as matters of fact. Intelligent costing can provide the facts, and on their existence industry will come more and more to rely for stability and confidence." We venture to think this book will help in the obtainment of the facts.

Considerable activity in the production of new experimental aircraft has to be recorded for the past year, and this fact is plainly evident from the large proportion of new material included in the latest edition of "*Janes' All the World's Aircraft*," which has just made its appearance. This well-known and very useful publication, which is edited and compiled by Mr. C. G. Grey and has now reached its thirteenth year of issue, provides a simple and convenient means of enabling anyone interested in the subject to keep abreast of aeronautical developments in all parts of the world. The book is divided into four main sections, the first of which consists of a series of historical notes on the year's work of each nation in military, naval and civil aviation, and also includes lists of the various officials, departments, associations and publications relating to aeronautical matters. In the next section, which occupies the greater part of the volume, full particulars are given of the machines constructed in each country, the machines being illustrated by numerous photographs and scale drawings. Two sub-sections in this part of the volume are devoted to gliders and helicopters, respectively, though we note from the preface that the editor is no more favourably impressed with the possibilities of the latter type of aircraft than we are. The remaining sections of the work deal with aero engines and airships, and although no important developments have to be recorded in the former, evidence of detail and general improvements in design is discernible by comparison with earlier volumes. As far as this country is concerned, airship development seems to be completely stagnant and most of the space in this section of the book is devoted to Italian and American airships. At the moment, interest in airships centres mainly on

the vessel under construction at the German Zeppelin Works, for the United States Navy, but, beyond the fact that it will have a capacity of nearly 2,500,000 cub. ft., no technical data are available. As the editor invites criticism of the volume we would suggest that a rather more detailed index, giving the names of machines, would be an improvement, although, in general, the arrangement of the work is quite convenient and satisfactory. The book is published by Messrs. Sampson Low, Marston and Co., Limited, 100, Southwark-street, S.E. 1, and its price is 42*s.* net.

An enormous amount of research work has been carried out on special alloy steels of every description, and detailed information on the subject is to be found in the transactions of the Iron and Steel Institute and kindred societies, also in technical periodicals and treatises. The very wealth of the matter at the disposal of the inquiring metallurgist is apt to become bewildering, and long and painstaking scrutiny of indexes often proves arduous. Mr. Thos. H. Burnham, B.Sc.(Lond.), has written a concise technical survey of the nature and scope of this important branch of metallurgy. The book is entitled "*Special Steels*," and is published by Sir Isaac Pitman and Sons, Limited, London. It is one of a series of technical primers edited by Mr. R. E. Neale, B.Sc., and the net price is 5*s.* Chiefly founded on the researches of Sir Robert Hadfield, the work briefly reviews current knowledge and practice and gives useful information on the history, constitution, manufacture, working, heat-treatment, and uses of alloy steels. Turning to one of the latest developments, namely, the Firth-Brearley rustless steel, we find that the author gives a capital review of the whole subject extending over some 13 pages, complete with a diagram of mechanical properties and several useful tables. All the alloy steels in everyday use are dealt with in the same workmanlike fashion. The author is plainly desirous of holding the reader's interest and has undoubtedly succeeded in producing a remarkably attractive and serviceable little work.

INDUSTRIAL NOTES.

THE twenty-fourth annual report for the year 1922–23, recently issued by the General Federation of Trade Unions, shows that the membership has fallen to 1,056,131 for the 125 societies affiliated, as compared with 1,371,634 for 126 societies during the preceding twelve months, and with 967,257 members and 156 societies in 1914. The receipts from members showed a total of 64,883*l.* 2*s.* 8*d.*, as compared with 85,450*l.* 7*s.* 7*d.* for the preceding twelve months. The reserve fund was 94,396*l.* plus a sum of 13,160*l.*, benefit overclaimed and to be repaid; the reserve fund for the preceding twelve months stood at 127,409*l.*

The National Union of Railwaymen discussed at their annual conference held at Crewe last week the question of the 6*s.* 6*d.* reduction in the war bonus of the railway shopmen. They passed a resolution that the question be dealt with by the same machinery as for the traffic grades; the companies had proposed the Industrial Courts, but the National Union of Railwaymen proposed the National Wages Board. The resolution reads as follows: "This Congress regrets the friction existing in the railway services owing to the exclusion of shopmen from the operation of the national machinery for negotiation which has in the main worked satisfactorily for about 80 per cent. of the railway staff. It therefore places on record its considered judgment that there can be no permanent peace in the industry until all railway employes are enabled to have their rates of wages and conditions of employment negotiated through the same tribunal, so establishing equality of treatment and providing for the solution of railway labour problems in a broad and comprehensive manner." The resolution was passed unanimously.

At a subsequent meeting of the conference, a resolution was passed advocating the amalgamation of the Associated Society of Locomotive Engineers and Firemen, and of the Railway Clerks' Association, with the National Union of Railwaymen, so as to form one body covering all the men engaged in the railway service. The latter union, in order to secure amalgamation, was prepared to give absolute autonomy to the locomotive men in everything that affected their interests.

Speaking at Bradford on the 6th inst., on the occasion of the annual general meeting of the Bradford and District Branch of the Federation of British Industries, Sir Eric Geddes said that in many industries of which he was able to obtain intimate knowledge to-day, the great difficulty was that we were killed by the weight of overhead charges. The volume of the trade was insufficient to carry the overhead charges in competition with countries, which, like the United States, had large outputs, and were, therefore, able to spread their overhead charges. We had somehow or other to get the cost of production down if we were going to compete in the markets of the world. There might be industries where wages were unduly high, and there, he agreed, great difficulties arose, but there were other industries where wages were not unduly high, but where the standard of output per man-hour was unduly low. This was emphasised by the exchange situation in Europe, and by the great improvement in efficiency—in output per man-hour—of the United States. In America, since 1921, there had been an all-over improvement of 15 per cent. in the industrial efficiency of the operative. He did not know whether this was because America had become dry or whether it was due to a better organisation of industry and a higher standard of factory management and efficiency. He would be very surprised if anyone could see a general improvement of 15 per cent. in the last two years in this country although undoubtedly in certain industries and certain works this, and even more, had been obtained. This improvement could be brought about, either voluntarily in order to develop trade, or by mere force of economic circumstances. Taking, for instance, the improvement in output of the coal miner, economic pressure there had had the result of largely improving the efficiency of the worker. He knew that it was customary to laugh at the efficiency engineer, to belittle his efforts, to treat him as a crank. Even in America he was not looked upon as infallible. At the same time we should not treat him altogether lightly, and as a newcomer into industry, but as one who had been connected with manufacturing all his life.

The Miners' Federation of Great Britain are holding their annual conference this week at Folkestone. In his presidential address, Mr. Herbert Smith said they were glad to see that several of the mining districts were to-day receiving advances in wages above the minimum. Many of the piece-workers were now earning fair wages by hard, grinding toil at the coal face. There were, further, some day-workers whose standards had improved since 1914, and who were to-day getting more than 20 per cent. above the 1914 wages. There were, however, many thousand others whose day wages were not a penny more than the 20 per cent. above the 1914 figure, whilst the cost of living was 69 per cent. above the pre-war cost. The Federation aimed at providing the men with a wage sufficient to ensure to them the pre-war standard of living, and this would be possible were the coalowners to co-operate with the Federation, which they refused to do. He warned the coalowners that in the better-off districts the agreement had yielded a much higher profit per ton than could be justified, and steps would soon be taken to place it on a more just basis. Mr. Smith was decidedly against ending the agreement now, as the step would lead to disaster, but some of its clauses should be modified, especially that relating to the proportion which profits bore to wages. The reduction in miners' hours from eight to seven per shift had been one of the greatest blessings conferred upon the men, and they would never go back upon it, whatever were the circumstances. Among the resolutions passed was one to agitate for two weeks' holiday per year for all mine workers. A resolution demanding a 6-hour shift and a five-day week for all mine workers without decrease in wages, with a view to absorb the unemployed workers, was referred to the Business Committee and will be dealt with later.

Since the breaking out of the unauthorised strike among the dockers at various ports, to which we referred on page 25 *ante*, the leaders have not ceased to point out to the men the unlawfulness of their action in not keeping an agreement duly entered into by the union with the employers. At the time of writing there are signs that the men are gradually returning to work at some ports.

It is announced that the members of the Boilermakers' Society have rejected the employers' terms by more than a two-thirds majority, the votes for accepting the employers' terms numbering 7,415, and those against 16,859, a majority against of 9,444. There may be still a few votes to include in the above figures, but they are not likely, it is supposed, to change the result to any great extent. The dispute has now lasted over more than 10 weeks, during which time the men locked out have been in receipt of dispute benefit. The Executive of the society are said to be considering a scheme for increasing this benefit.

ROYAL COMMISSIONERS FOR THE EXHIBITION OF 1851 POST GRADUATE RESEARCH SCHOLARSHIP IN NAVAL ARCHITECTURE (1923).—This scholarship (250*l.* per annum for two years) has been awarded by the Royal Commissioners for the Exhibition of 1851 on the recommendation of the Council of the Institution of Naval Architects, to Mr. Ebenezer Smith, B.Sc., of Glasgow University.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—While current output is on a reduced scale owing to the completion of stock-taking operations and renewals and repairs to plant, the general trend of business is in an upward direction, and in most quarters the immediate outlook is viewed with quiet optimism. The manufacture of basic steel is proceeding at a restricted level. The bulk of contracts placed earlier in the year have expired, and new commitments of a minor magnitude have been entered upon. Continental competition is again influencing the market, though the handicap on output in the French steel-making areas induces local makers to hope for busier times and to put an increasing tonnage into stock. The output of steel in Sheffield and district during May, according to official returns, was at a very high level. The gross quantity produced was 111,000 tons, compared with 108,000 tons in April and 45,000 tons in the corresponding month of 1922. Slightly more than half was basic steel, and rather more than a quarter acid steel. The market for raw and semi-finished materials tends to sag. Makers of foundry iron are offering supplies locally at a reduction of from 7*s.* 6*d.* to 10*s.* a ton on the quotations ruling a month ago, but consumers are buying very sparingly, and unless the position improves it is not unlikely that several furnaces will be damped down. More coke is available at the moment for pig-iron production, though Continental inquiries are again becoming a strong feature, and sales covering shipments to the end of the year have been entered into at much more lucrative rates than obtain for inland supplies. Engineering works are more or less marking time, with here and there substantial bookings, mostly in the form of engineering plant, railway materials, colliery apparatus, and tramway requisites. The automobile section shows promise of improved conditions. More inquiries are in circulation from British manufacturers of pleasure cars for chassis parts and special steel fittings. Makers of wire rods and wire rope are uniformly busy. In the lighter sections India and Australia figure as prominent buyers of implements and tools.

South Yorkshire Coal Trade.—Output at collieries has been hampered by shortage of wagons arising from the dockers' dispute, but on the whole pits are free from stocks. Export sales, particularly to France and Belgium, are maintained at a high level, though the requirements of inland consumers are far from robust. Smalls and brights are a shade easier, but coking slacks are in short supply at maximum prices. The house-coal trade is at its lowest level, consistent with the usual midsummer shrinkage. Quotations:—Best branch handpicked, 32*s.* 6*d.* to 34*s.* 6*d.*; Barnsley best Silkstone, 28*s.* to 30*s.*; Derbyshire best brights, 25*s.* 6*d.* to 27*s.* 6*d.*; Derbyshire best house coal, 23*s.* to 24*s.* 6*d.*; Derbyshire best large nuts, 20*s.* 6*d.* to 22*s.* 6*d.*; Derbyshire best small nuts, 18*s.* to 20*s.*; Yorkshire hards, 21*s.* to 23*s.*; Derbyshire hards, 20*s.* to 22*s.*; rough slacks, 12*s.* to 14*s.*; nutty slacks, 11*s.* to 13*s.*; smalls, 7*s.* to 9*s.*

THE FORTHCOMING INTERNATIONAL SHIPPING, ENGINEERING AND MACHINERY EXHIBITION.—The International Shipping, Engineering and Machinery Exhibition to be held at Olympia will open on the 31st of next month and will continue until September 22. The exhibition is organised by Messrs. F. W. Bridges and Sons, Limited, Southampton Row, W.C., and follows others of an eminently successful character which were in the same hands. A pamphlet has now been issued for information for exhibitors which will be of assistance to them in making the necessary arrangements for their stands, as regards power and lighting, telephones, &c. Regulations are also given concerning the use of acetylene, &c., and instructions in the transport and delivery of exhibits. Work on the stands may be commenced on August 21, at 8 p.m., and it is intended that it should be completed by the 30th at 10 p.m. Dismantling at the close of the exhibition will commence on Monday, September 24, and must be completed by Saturday of the same week at 6 p.m.

RESEARCH PROFESSORSHIPS.—The Council of the Royal Society after mature consideration have decided to use Sir Alfred Yarrow's gift of 100,000*l.* to found a number of professorships of research. They state that there has been a marked deficiency of position in which a man of proved capacity could continue to regard research as his main occupation. Cases like that of Charles Darwin must, in fact, always be exceptional. In his instance, the possession of ample private means enabled Darwin to devote his whole life to research and to change our whole outlook in certain highly important departments of scientific inquiry. Probably the Royal Society in coming to the conclusion stated have been guided by a German pre-war precedent, as we believe that the German Government had established a number of professorships held on very much the same terms as these proposed for the new foundations. Of course, the success of the scheme will depend upon the class of man selected for the new appointment. It is most essential that the holders shall be drawn from the very small band of those gifted with real insight and creative thought, and not from the very numerous body of those who are in all essentials merely high-class mechanics, capable of constructing ingenious mechanism, of devising pretty experiments, and of making accurate measurements, who in the very nature of things form the main mass of the Fellows of the Royal Society. Such men no doubt contribute much to scientific data, but the proposed professorships should be reserved for the exceptional few who have shown that they have the capacity to advance scientific thought.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—There is practically no new feature noticeable so far as Cleveland pig-iron is concerned. A few inquiries are circulating, but the whole of the output is not taken up, and stocks, though as yet not heavy, are steadily increasing at makers' yards. No. 1 is still extremely scarce, and the few small parcels that come on the market from time to time continue to command high figures in comparison with rates ruling for other grades, all of which are plentiful. No. 1 is 120*s.* to 125*s.*; No. 3 g.m.b., 110*s.*; No. 4 foundry, 105*s.*; and No. 4 forge, 102*s.* 6*d.*—all f.o.t. makers' works, or f.o.b. Tees.

Hematite.—Supply of East Coast hematite is a good deal in excess of requirements, but producers are emphatic in their declaration that existing conditions prohibit further fall in quotations, and rather than make more price concessions to any extent several firms have decided to follow the example of Messrs. Palmer and damp down furnaces. A few fairly good sales, however, have recently been put through, and hope is entertained that further curtailment of output may be avoided. Both for home purposes, and for shipment overseas, Nos. 1, 2 and 3 are quoted 110*s.*, though it is understood that figure has been shaded. No. 1 is at a premium of a shilling.

Blast-Furnacemen's Wages Advanced.—The average net selling price of No. 3 Cleveland pig-iron for the three months ending June 30 last has been certified at 112*s.* 1·64*d.* per ton, as compared with 92*s.* 10·69*d.* per ton for the previous quarter. This means an advance in North-East Coast blast-furnacemen's wages of 19·25 per cent., raising wages from 31·25 per cent. above the standard, to 50 per cent. above the standard.

Foreign Ore.—Business in foreign ore is stagnant, and the quotation of 24*s.* c.i.f. Tees for best rubio is purely nominal.

Blast-Furnace Coke.—Blast-furnace coke is still very scarce, but it is easier, the concession price to local regular customers now being in the neighbourhood of 40*s.* delivered.

Manufactured Iron and Steel.—Very little new of moment is ascertainable concerning finished iron and steel. Sales are difficult to arrange; manufacturers offer to make price concessions but fail to tempt customers. Sellers ask the following figures for home trade:—Common iron bars, 12*l.*; iron rivets, 14*l.*; packing (parallel), 8*l.* 10*s.*; packing (tapered), 11*l.* 10*s.*; steel billets (soft), 10*l.*; steel billets (medium), 10*l.* 10*s.*; steel billets, (hard), 10*l.* 15*s.*; steel boiler plates, 14*l.*; steel ship, bridge and tank plates, 10*l.*; steel angles, 9*l.* 10*s.*; steel joists, 9*l.* 15*s.*; heavy sections of steel rails, 10*l.*; fish plates, 14*l.*; black sheets, 13*l.* 10*s.*; and galvanised corrugated sheets (No. 24 gauge in bundles), 18*l.* 10*s.*

CONTRACTS.—It is announced that Sir W. G. Armstrong, Whitworth and Co., Limited, have secured an order during the last few days for 25 heavy main line locomotives for the Buenos Ayres Great Southern Railway. These locomotives, which are intended for goods traffic, are of the 4-8-0, three-cylinder superheated type, with double bogie tenders for a gauge of 5 ft. 6 in. The locomotives are arranged to burn oil. They will be built at the firm's Scotswood works, Newcastle-on-Tyne.

PUZZOLANIC CEMENT.—We are informed by the Department of Scientific and Industrial Research, 16, Old Queen-street, S.W. 1, that a first experiment with spent shale from the Scottish oilfields at the Building Research Board's experimental station has produced a puzzolanic hydraulic cement of a tensile strength at three months' age greater than that required for Portland cement by the British Engineering Standards Association standard specification. The attention of Mr. H. D. Weller, Director of Building Research, was directed to this waste material by Dr. A. P. Laurie, of Edinburgh. Samples were obtained from the Research Association of the Shale Oil Industry. The cement is of a pleasant light red colour, and is much harder than ordinary Portland cement.

THE INSTITUTION OF MINING ENGINEERS.—In connection with their experimental work on the relative inflammability of different coal-dusts, the Safety in Mines Research Board propose to arrange for a series of coaldust explosion experiments at the Mines Department Experiment Station, Eskmeals, Cumberland, during the summer, somewhat similar to those held last year, with the object of impressing upon mine workers the importance of the coal-dust problem. The Board is of opinion that as many as possible of those engaged in or interested in the coal mining industry should witness these demonstrations, and they have accordingly made arrangements for the experimental station to be open to visitors on each Sunday during the undermentioned period, when a large-scale coal-dust explosion will take place, followed by another demonstration to show the efficacy of stone-dust in preventing the ignition of coal-dust. The demonstration will be made each Sunday from the 15th inst. to September 30, inclusive, with a possible extension to the first two Sundays in October. Individuals or parties may proceed independently from any district and on any Sunday to see the demonstrations, but in this event they should notify the Board seven days in advance, stating: (*a*) The date chosen; (*b*) whether a demonstration of the value of stone-dust is desired; (*c*) the association, federation or institution to which the applicant or party belongs.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

The State of Trade.—The general trade of this country is far from satisfactory at the present moment, and the outlook is rather obscure. The half-year period now closing has been marked by a depressed feeling in most industries, and the aftermath of the war is mainly responsible for present conditions. Labour troubles abound on all sides, and it would seem as if a state of peace for any length of time was in future to be denied us. In the engineering and allied trades the lock-out of the boilermakers has had a serious effect, and even an early settlement of that dispute will not ensure a return of prosperity to general trade. Shipbuilding concerns have few contracts to commence, and those doing repair and overhaul work have recently seen many good jobs sent over to the Continent. That is most unsatisfactory from a national point of view because the spending power of the money involved both in wages and material is lost to the country. Short time has been all too common in many of the engineering shops, and in some of them the annual fair holiday period will extend to nearly three weeks. The cost of material in general is considered too high to permit of launching out boldly on schemes, many of which are badly required, and the demand overall is being confined to works of immediate importance. What the future holds in store no one can tell, but the trade outlook for the second half of this year is indeed very clouded.

Scottish Steel Trade.—The steel trade of Scotland has recently been passing through rather a quiet time, and it has been difficult to keep the limited plant in operation going without interruption. The contracts which were booked some time ago and which are now gradually getting cleared up have been a perfect godsend, because of the scarcity of new business of late. Pressure for deliveries this week, before the holidays, has not been felt to any extent, and a dull tone has been very general. The shipbuilding trade being almost at a standstill, the demand for ship plates, &c., has been infinitesimal recently, and until the boilermakers return to work, the steel trade will continue to suffer rather badly. The black sheet makers have been doing fairly well considering the times, but inquiries are not so plentiful again. Prices are steady, but a cut is anticipated before long. To-day's quotations are:—Boiler plates, 13*l.* per ton; ship plates, 10*l.* 5*s.* per ton; sections, 10*l.* per ton; and sheets, $\frac{3}{8}$ in. to $\frac{1}{2}$ in., 12*l.* 10*s.* per ton, all delivered Glasgow stations.

Malleable Iron Trade.—No change falls to be recorded in the West of Scotland malleable iron trade, and conditions this week are very similar to those which have prevailed for some time back. The demand continues so poor that an extended holiday is very probable. Export business has not come away as was expected despite the fact that a fair number of inquiries were recently in the market. The price of "Crown" bars is steady at 12*l.* per ton, delivered Glasgow stations.

Scottish Pig-Iron Trade.—The output of Scottish pig-iron was recently curtailed, and still there is more than ample to meet all demands received by producers. The export sales have decreased to a marked extent, and home consumers, both of hematite iron and foundry iron, have little need for anything beyond quite a small weekly tonnage. The outlook is not very bright. The following may be taken as to-day's market. Quotations: Hematite, 5*l.* 17*s.* 6*d.* per ton, delivered at the steel works; foundry iron, No. 1, 5*l.* 12*s.* 6*d.* per ton, and No. 3, 5*l.* 7*s.* 6*d.* per ton, both on trucks at makers' yards.

Scottish Pig-Iron Shipments.—The shipments of Scottish pig-iron from Glasgow Harbour for the week ending last Saturday, July 7, amounted to 1,041 tons. Of the total, 1,011 tons went foreign and only 30 tons coastwise. For the corresponding week last year the figures were 61 tons foreign and 469 tons coastwise, making a total of 530 tons.

EMPIRE ROLLER BEARING.—We regret that in noticing a catalogue of the Empire Roller Bearing Company (1923), Limited, of Thornbury, Bradford, Yorks, in our issue of June 22 last, page 787, we referred to this bearing as a "solid" roller bearing. The chief feature, however, of the Empire roller bearing is that it is of "divided" construction, which facilitates the erection and dismantling of shafting, pulleys, &c.

BRITISH ENGINEERING STANDARDS ASSOCIATION.—The withdrawal of British standard specification 72—1917 (Electrical Machinery) from circulation is announced. This document is now under revision and will be divided into the following sections, each of which will be issued as a separate publication as and when ready: (*a*) Industrial machines (British standard specification 168—1923, already published). (*b*) Large machines, (*c*) transformers, (*d*) rotary converters, (*e*) traction motors. The four latter are in course of preparation.

THE ROYAL SOCIETY OF ARTS.—The annual report of the Council of this Society, which was presented to the members on June 27, shows that the system of examinations conducted by the society is very highly appreciated. The entries continue to grow in a most satisfactory manner; for the March series this year the figures were 23,363, as compared with 22,160 last year, and for the May series 45,888, as against 38,171 last year. The total number of entries for 1923 was 68,241; for 1922, 60,331; for 1921, 55,182. The record before the war was 37,974 in 1914.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Coal Trade.—There has been little change in the coal trade position during the past week. The unofficial strike of dockers and the consequent holding-up of discharging work, in individual cases upset the arrangements of collieries and exporters. The quantity of shipping affected was, however, proportionately very small. It was, however, sufficient to compel some colliery salesmen to modify their quotations for quick loading and enable buyers, able to take advantage of the opportunity, to secure parcels below market values. The Swedish State Railway have contracted for 20,000 tons of large dry coals at 27*s.* 6*d.* f.o.b. and the French State Railways have placed orders for 20,000 tons and 10,000 tons respectively. The volume of business passing on the market, however, is not extensive, and buyers, in the majority of cases, are proceeding on hand-to-mouth lines. The best large coals are fairly comfortably situated and salesmen are able to hold out in most cases for 32*s.* 6*d.*, but here and there a 1*s.* less is accepted for quick delivery. Second Admiralty large is round 30*s.* and Monmouthshires 28*s.*, with best steam smalls available at 23*s.* and drys from 15*s.* The pit-head price of best house coal has been reduced by 2*s.* 6*d.* per ton to 32*s.* 6*d.* from to-day and the inferior grades have also been reduced proportionately. Exports as cargo last week totalled 521,700 tons compared with 626,830 tons in the previous week. Of the total, 224,880 tons were despatched to France, 76,970 tons to Italy, 67,000 tons to South America, 14,080 tons to Spain, 5,900 ton to Portugal, 1,450 tons to Greece, 47,360 tons to British coaling depots, 4,060 tons to Canada, 18,920 tons to Belgium, 5,990 tons to Holland, 26,490 tons to Germany, and 28,540 tons to other countries.

The Cornborough Steamship Company.—Shareholders in the Cornborough Shipping Line, Limited, which owns eight steamers of 47,000 tons deadweight, and which was formed in 1919, have received a circular containing an offer from the chairman, Sir William Reardon Smith, Bart., to exchange one St. Just Steamship Company, Limited, 1*l.* share for every three 1*l.* shares in the Cornborough Company. The circular states that in the last annual report dated December 14, it was pointed out that the company was then indebted to the bank to such an extent that there were no funds available for the purpose of meeting taxation liabilities, and that there had been no improvement in the position. Owing to the enormous depreciation in the market value of shipping property the assets of the company, it is stated, are now only valued at less than 200,000*l.*, not sufficient to cover the liabilities. The St. Just Company, of which Sir William is also chairman, owns 24 vessels of 212,475 tons deadweight. Sir William is making the exchange of shares from his personal holding in order that those shareholders who have supported him for so many years may still have an opportunity of saving some part of their original investment. The directors, it is stated, have given careful consideration to a possible reconstruction of the company, but no scheme presents itself which would benefit the shareholders.

THE AERATION OF SEA WATER.—Recent investigations by Messrs. Butler and Coste have shown that sea water frequently holds in solution much more than its due proportion of oxygen. The surplus over the equilibrium limit varies with the time of the year, and in the summer months may be 77·5 per cent. more than the water can permanently retain under similar conditions as to temperature and pressure. This great excess of oxygen is considered to be due to the decomposition of CO_2 by the plankton of the sea, and in view of the wide extent of the oceans it is suggested that the total oxygen thus set free is far in excess of that liberated by the ordinary vegetation of our globe.

PETROLEUM AS A CATALYTIC PRODUCT.—A curious observation is reported by Mr. W. Ramsay in a paper read last April before the Liverpool section of the Society of Chemical Industry. Examining crude oils from various parts of the world he found that each contained nickel, apparently in the state of a colloidal suspension. It has been shown that carbon, carbon monoxide and even carbon dioxide can be hydrogenated, in presence of a nickel catalyst, to form methane at comparatively low pressures and temperatures, and higher hydrocarbons under higher temperatures and pressures. It is suggested accordingly that the nickel found in all these crude oils may have been the responsible factor for their original formation, and that the petroleum deposits may thus have been formed independently of organic life.

SEWAGE PUMPS AND MOTORS, TORONTO.—H.M. Trade Commissioner at Toronto reports that the City of Toronto are inviting tenders for the supply and installation at the Strachan-avenue Sewage Pumping Station of two 2,880,000 imperial gallon centrifugal sewage pumps direct-connected to three-phase induction motors. Sealed tenders addressed to the Mayor and Board of Control of the City of Toronto must be received not later than August 21, accompanied by a deposit equal to 2½ per cent. of the amount of the contract. Copies of the tender form, specification and drawing are available for inspection by British firms, who are in a position to tender, on personal application being made to the Department of Overseas Trade (Room 50). A second set of the documents will be forwarded on loan, in order of application, to firms who are unable to attend in London.

TWELVE-SPINDLE RAIL SLOT-DRILLING MACHINE.

CONSTRUCTED BY MESSRS. RICHARDSONS, WESTGARTH AND CO., LIMITED, ENGINEERS, MIDDLESBROUGH.

(*For Description, see Page* 46.)

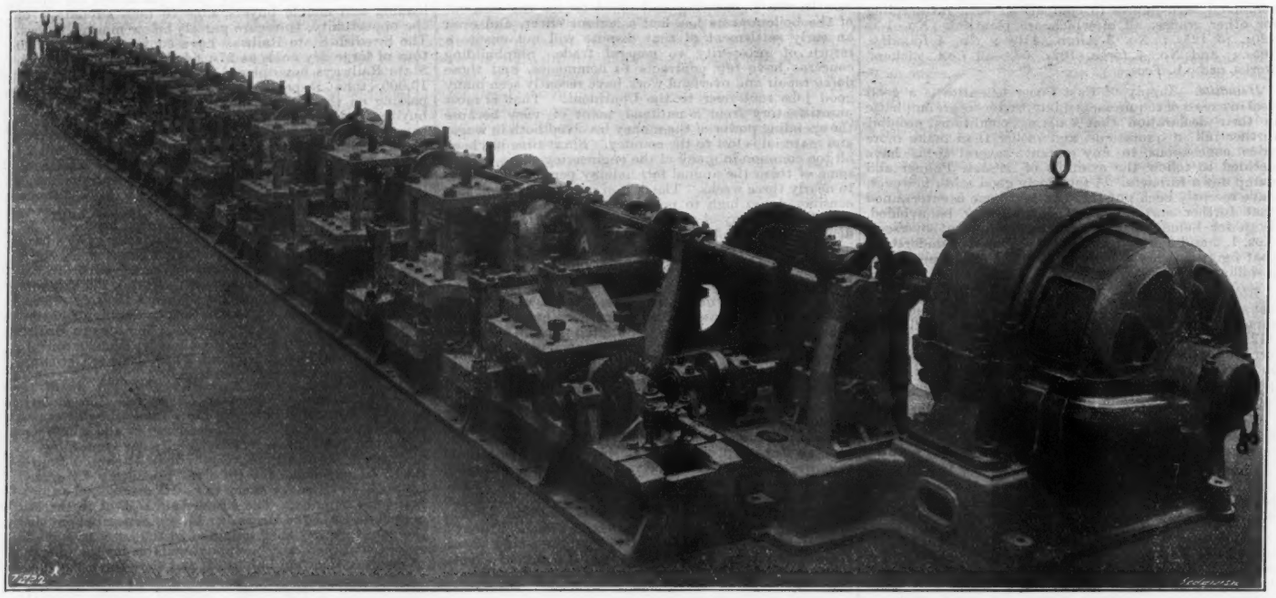


FIG. 8.

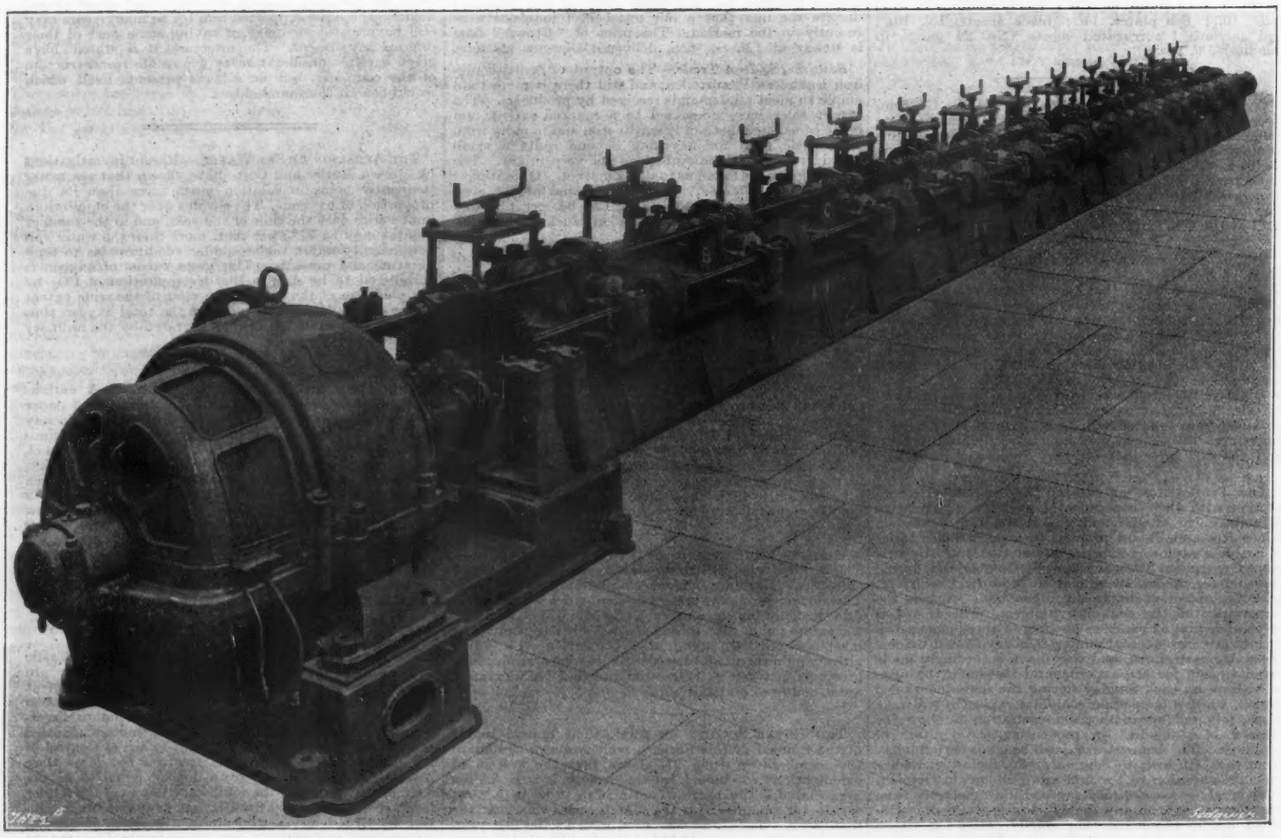


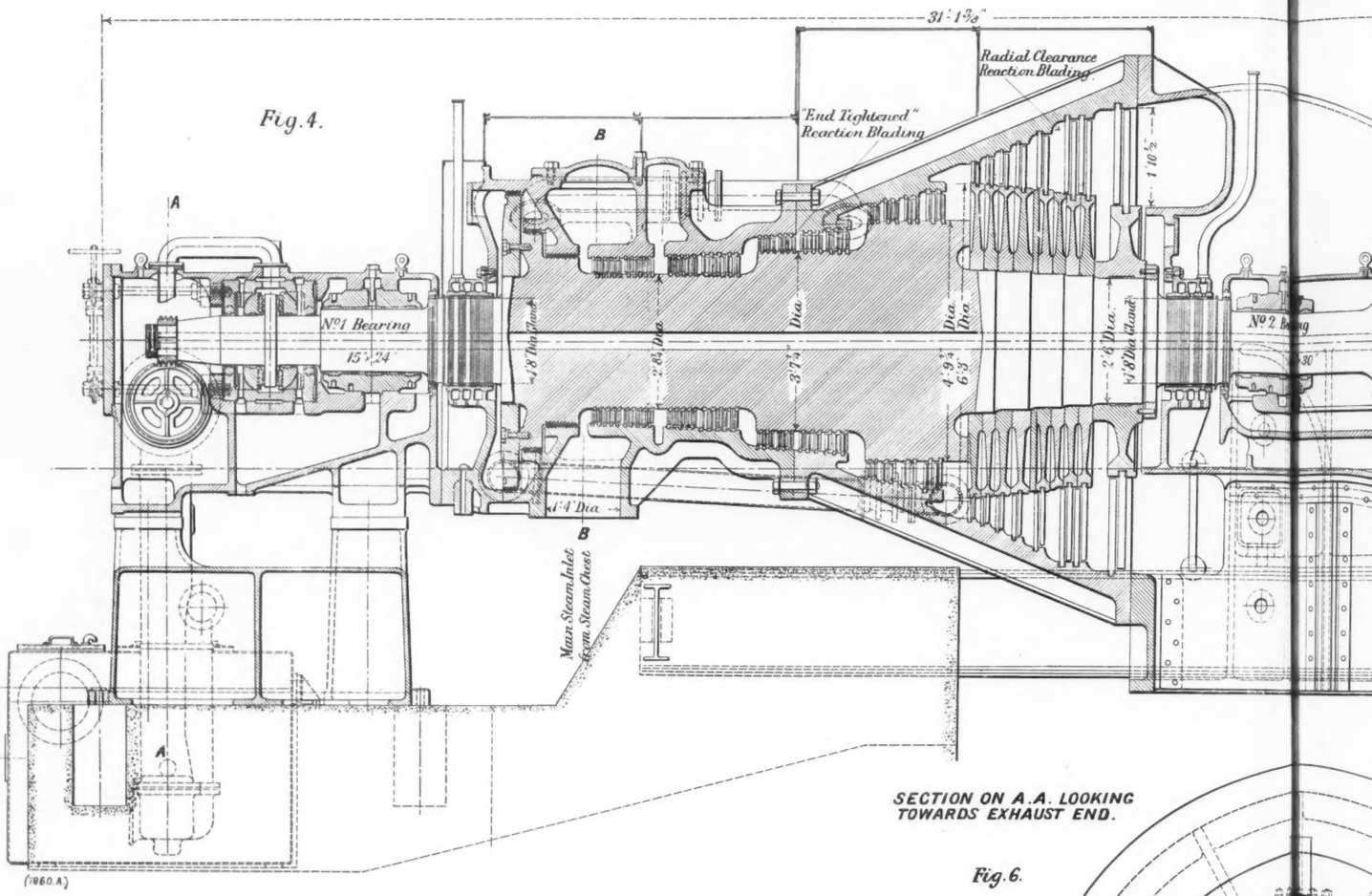
FIG. 9.

20,000-KW. TURBO-ALTERNATOR AT THE SHANGHA

CONSTRUCTED BY MESSRS. C. A. PARSONS AND CO., LIMITED, ENGINE

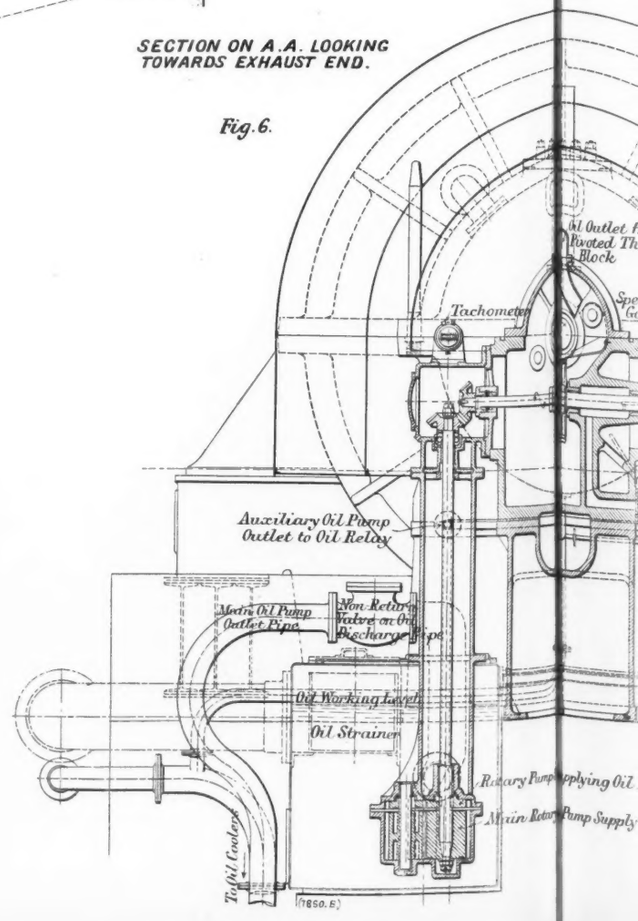
(For Description, Page 39.)

Fig. 4.



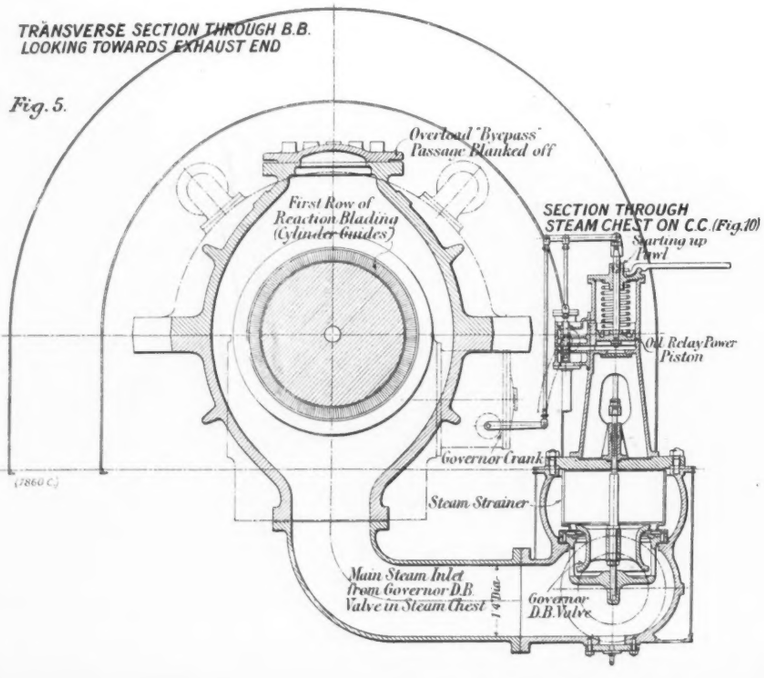
SECTION ON A.A. LOOKING TOWARDS EXHAUST END.

Fig. 6.



TRANSVERSE SECTION THROUGH B.B. LOOKING TOWARDS EXHAUST END

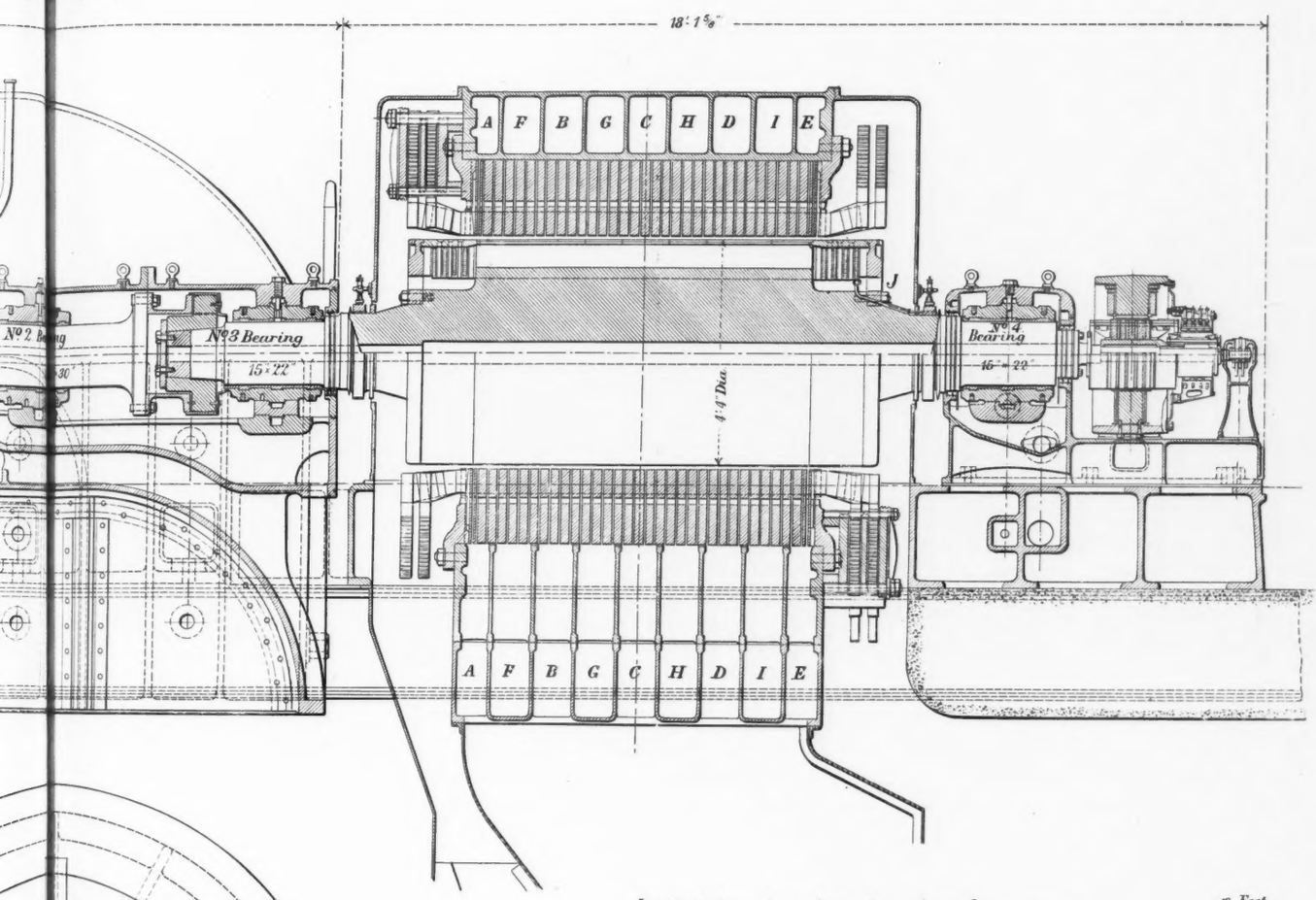
Fig. 5.


Overload "Bypass" Passage Blanked off
First Row of Reaction Blading (Cylinder Guides)
SECTION THROUGH STEAM CHEST ON C.C. (Fig. 10)
Starting up Pawl
Oil Relay Power Piston
Governor Crank
Steam Strainer
Main Steam Inlet from Governor D.B. Valve in Steam Chest
1'4 Dia
Governor D.B. Valve
(1860.C.)

SHANGHAI MUNICIPAL ELECTRICITY WORKS.

..., LIMD, ENGINEERS, HEATON WORKS, NEWCASTLE-ON-TYNE.

escription Page 39.)



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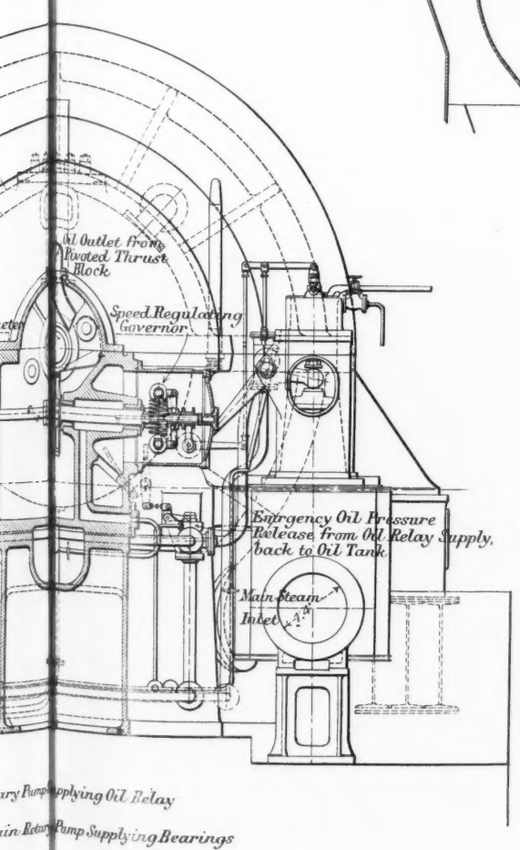
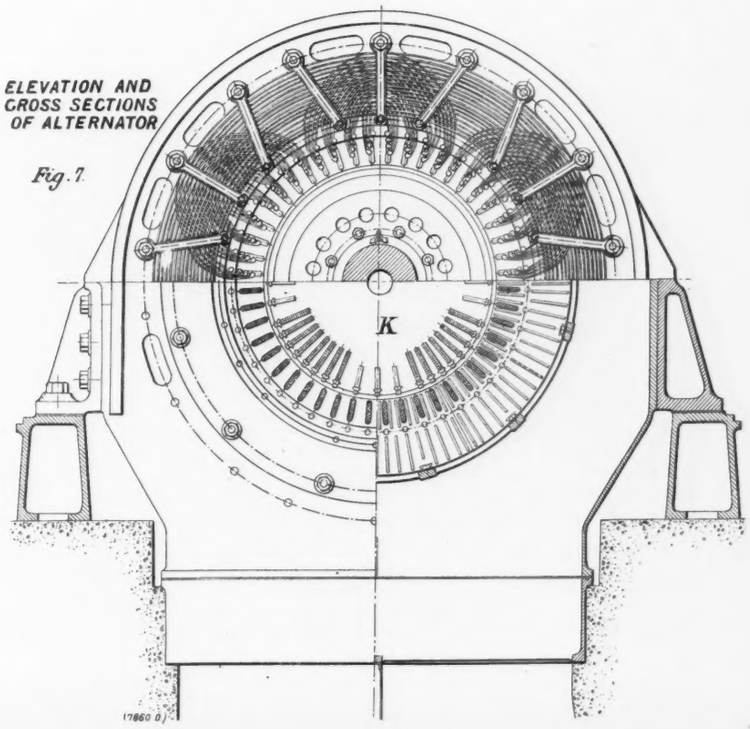

Oil Outlet from Pivoted Thrust Block
Speed Regulating Governor
Emergency Oil Pressure Release from Oil Relay Supply, back to Oil Tank
Main Steam Inlet
ary Pump supplying Oil Relay
ain Rotary Pump Supplying Bearings



ELEVATION AND GROSS SECTIONS OF ALTERNATOR

Fig. 7.

ENGINEERING.

Offices for Publication and Advertisements, 35 and 36, Bedford Street, Strand, London, W.C.2.

We desire to call the attention of our readers to the fact that the above is our SOLE ADDRESS, and that no connection exists between this Journal and any other publications bearing somewhat similar titles.

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TELEPHONE NUMBERS—3663 and 8598 GERRARD.

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ADVERTISEMENT RATES.

The charge for advertisements classified under the Headings of Appointments Open, Situations Wanted, Tenders, &c., is four shillings for the first four lines or under, and one shilling per line up to one inch. The line averages seven words. When an advertisement measures an inch or more the charge is 12*s.* per inch. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. The pages are 12 in. deep and 9 in. wide, divisible into four columns of 2¼ in. in width. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

TIME FOR RECEIPT OF ADVERTISEMENTS.

Advertisements intended for insertion in the current week's issue must be delivered not later than First Post on Thursday. In consequence of the necessity of going to press early with a portion of the edition, alterations for standing advertisements should be received on the Friday previous to the day of publication.

All accounts are payable to ENGINEERING, LTD. Cheques should be crossed "The National Provincial and Union Bank of England, Limited, Charing Cross Branch." Post-Office Orders should be made payable at Bedford-street, Strand, W.C. 2.

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SOUTH AFRICA : Central News Agency, Limited, Head Office—Johannesburg ; and Pretoria, Cape Town, Port Elizabeth, Bloomfontein, Durban, and their various branches and bookstalls throughout South Africa. Also Wm. Dawson and Sons (South Africa), Limited, 29 and 31, Long-street, Capetown.

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UNITED STATES : For subscription, New York ; W. H. Wiley 432, Fourth Avenue. For Advertisements : J. S. Allan 30, Church-street, New York.

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ENGINEERING.

FRIDAY, JULY 13, 1923.

PATENT RIGHTS AND TEAM PRODUCTION.

LAWS impose restrictions, and to a free people their institution can be justified only if they serve a public purpose of an importance comparable with the restrictions involved. The patent law, which restrains manufacturers from producing what they believe to be profitable, and limits consumers in their choice of the sources from which they can buy, is no exception to this rule, and the community bears it in the belief that it serves a sufficiently important purpose. That purpose is to encourage inventors—a term that for this purpose must be taken to include manufacturers and others who provide the capital on which inventions are sought and worked out—to search for new manufactures or improvements, in face of the foreknowledge that most of the searches will be costly and unsuccessful. The transaction by which letters patent are granted is that the inventor shall have introduced a new or improved practical manufacture into the realm, and with the utmost candour and good faith have described to the best of his own knowledge at the date of his application the way in which the invention may best be practised. If the grant is to give the desired encouragement, it is in the interest no less of the community than of the patentee that the promised protection shall be given with the same utmost good faith as is exacted from the patentee in the disclosure that forms the consideration for the grant.

This is in no way because inventors have any inherent right even to a limited monopoly of their inventions. Monopolies in themselves have always been odious to public feeling, and the patent law itself came into being merely as an exception to an Act by which monopolies, after a sufficient period of notorious abuse, were ultimately proclaimed unlawful. The provisions of the patent laws of our own and other countries are directed mostly to protecting the community against the grant of letters patent to persons who had not given the specified consideration. Industry would be in a bad way under a patent law without some such provisions. Even as it is, the consideration must often be evaded. There used to be, and presumably still is, an unincorporated body of technological resurrection men, who at the excellent Patent Office Library and similar institutions earned an honest living by digging up dead and gone inventions from the files of old journals, or even from old patent specifications, and with the bones of these abortive inventions pegging out claims for new patents, to be sold for money to the ignorant or credulous, or used for blackmailing patentees of genuine inventions. Occasionally such researches may have led to the revival and working of an invention of merit that had been stillborn on its first incarnation ; but for the most part the results were merely paper patents, not entitled to protection within the spirit of the patent law, and welcome only to the patentees and such interested sea-lawyers as they might concern.

Genuine patentees have therefore an intimate interest in the existence of provisions for curtailing the operations of bogus patentees, and cannot well complain of the law if its provisions for their protection in this respect sometimes go further than was intended, and operate to deprive them of their expected monopoly. While, however, patentees may be estopped from complaining by the fact that they took their grants subject to the known risk that turned out against them, such occurrences must necessarily discourage future inventions. No Government guarantees its patents, but the promise of a patent even without such a guarantee leads inventors not unreasonably to think rather of the technical difficulties to be overcome than of legal objections to an invention that has overcome them. The fundamental purpose of the patent law makes it desirable that inventors should so view their prospects, and the law will attain its purpose much less completely if they cease to do so. At the present time, and indeed for many years past, it may be doubted whether the administration of patents does lead inventors to look on the promised protection with the confidence that the interests of the community require. To make the inducement of patent protection as effective for the State's purpose as it should be, the protection to genuine inventions ought to be more certain than it is.

The importance of the State's interest in making this inducement effective may perhaps be realised best by considering process patents. In the working of manufacturing processes the scale of operation has usually so considerable an effect on the result that even the next step to be taken in developing an invention cannot be settled safely until the process has been tried not on a model or in a laboratory, but on a full-size plant. A research that has to be conducted on units of this size is necessarily more costly and takes much longer than one that can be carried out on a small scale, and to work out an invention from its first conception to a successful result usually involves a considerable investment, of which the technical outcome is not certain until the investigation is completed. Progress in an industry using such processes is nevertheless essentially dependent on a sufficiency of such investigations. As in natural evolution, it is attained most effectively by the independent progress of individuals, and the gradual levelling-up of practice to the stage that the best individuals reach. The products of many industries, moreover, are the raw materials of other industries of as great or greater importance, and the progress of these customer industries depends essentially on that of the industry which supplies their raw materials.

Of industries so situated in both these respects no better illustration can be given than the steel-making and engineering trades ; and unfortunately they illustrate no less clearly the liability of genuine inventions to lose their patent protection through causes quite apart from their intrinsic merit. A particularly good instance, which now seems partly to be in suspense, is that of the manufacture of stainless steel. The patent history of this process has at best been unfortunate. The result first obtained was so much ahead of what at the time was believed to be possible that it was thought desirable to verify it by distributing some hundreds of samples among experienced persons and collecting their views. When in this way the original result had been confirmed the publication involved in this distribution was thought to have been so complete as to preclude an application for a British patent, but it was not too late for an application in the United States and other countries. During the war the entire output was commandeered for valves of aeroplane engines ; and when manufacture for civil purposes was resumed the application for a New Zealand patent was by oversight omitted until

after shipments of the product had been made to that colony. The American patent was challenged and fought. In the District Court in which the case was first heard, the judge found that while no one could have heard the patentee's evidence "without being persuaded of his absolute integrity and the moderation of his claims," the claims went further than could be supported in the face of previous disclosures. On appeal, however, as reported in these columns (ENGINEERING, May 4th, 1923, page 550), it was held that these paper disclosures, evidencing a widespread anxiety to obtain the result and unsupported by any evidence that the result had ever been obtained in practice before the plaintiff discovered and published his method, rather magnified than minimised or avoided the novelty and inventiveness of the invention. The judgment of the court below was accordingly reversed, and the patent was upheld.

It has now been announced that at the instance of a combination of English steel and cutlery makers the New Zealand patent has been revoked on the ground of the inadvertent export of some of the patented material before the application for the patent, and that the patents in other countries are to be attacked on the ground that the alleged invention for which they were granted was not new. We express no opinion on the legal merits of the parties in such proceedings when we say that before the introduction of stainless steel by the patentees whose invention is in question such a product had been sought for many years, but commercially had never been available. The recent trial of the American patents has given this view the sanction of the United States Appeal Court; and even the reversed judgment of the District Court found unreservedly, as stated above, that the claims were drawn with absolute good faith and moderation. The case is therefore not one of a paper patent founded on a prior invention, or even of a race to the Patent Office between simultaneous inventors, as happened, for instance, with the early incandescent electric lamp patents. It is, on the contrary, a body of manufacturers who seek to avoid the patents on the ground not of a prior or simultaneous invention introduced into industry by one of their own number or anyone else, but of some publication which, if it exists, has never led to the production of stainless steel in the British or any other market.

The manufacturers in question are the only competent judges of their own interests, and what is said to be their intended action is plainly within their legal rights. If, however, it was successful, it would afford a striking example of the failure of the existing law to uphold what has been held judicially and is known industrially to be a valuable pioneer invention. For the reasons discussed above industrial progress depends largely on the ventures of pioneer inventors. Nothing can more effectively obstruct their disposition to undertake the labour and considerable costs of the thorough investigations without which no solid progress can be made, or discourage young men of ability from devoting themselves to this hazardous, if fascinating work, or disable employers from offering them sufficient inducements to do so, than the uncertainty of protection for their invention in the event of its technical success. These considerations must in the long run affect the manufacturers who to-day are said to be seeking to defeat the patents for stainless steel. If successful attempts to avoid genuine patents were made often enough, it would become a question whether prior publication without industrial working could be maintained as a ground by itself for avoiding patents. It would indeed take no great number of such miscarriages to raise this question, if they were flagrant enough. Such a discussion, if it could be avoided, would be regrettable. Tinkering with codes and the resulting uncertainty of the law are always unsatisfactory, particularly when, as with the patent law, stopping one leak may be likely to enlarge another.

The true remedy seems rather to lie in recognising that in business, as in some other departments of conduct, such for instance as morals and sport, no codes can be effective and satisfactory unless they are supported by unwritten understandings, based on something like that utmost candour and good faith that is exacted from patentees, and that even the adverse American judgment found to have been amply shown in the present instance. Probably there has never been a time in British industry, and most of all in the engineering trades, when it had so much need of every means of advancement in its power. It ought surely in such circumstances to be possible for enlightened leaders of industry to devise means by which as far as possible improvements in manufacturing methods made by one of them should be made available for all, not by confiscating or socialising invention, but on equitable terms, without seeking technical objections against patents which in fact, in common knowledge, and on high judicial decision, cover the pioneer introduction into industry of a valuable product. The profit to be earned by each works depends not merely on the percentage of business it may succeed in wresting from its neighbours, but also on the total amount of the business in the industry on which that percentage is reckoned. This amount ultimately must be a function of the service that the arts concerned can render to their customers, which on the technical side is determined by their success in the constant struggle with the forces and for the resources of Nature. In that struggle the human industrial team could often go further if it recognised that Nature is willing to play the best ball of any number of them; and in times of stress and difficulty there is much to be said for the wisdom of discarding avoidable differences within the team, and finding fair conditions for putting its best ball foremost.

THE SHIPBUILDING INDUSTRY.

THE slight improvement in the shipbuilding industry of Great Britain and Ireland which we were able to record when dealing with the figures for the first quarter of this year, on page 469 of our last volume, has unfortunately not been maintained during the quarter just completed. Statistics issued this week by Lloyd's Register show that the tonnage in hand in this country has declined from 1,492,138 on March 31st to 1,337,759 on June 30th, the difference of 154,379 tons representing a drop of about 10 per cent. As compared with the figures for June 30th last year, which was 1,919,504 tons, the difference amounts to 581,745 tons—a reduction of over 30 per cent. There is still a certain amount of tonnage in the yards on which work has been suspended, the actual figure being about 130,000 tons, and subtracting the latter from the tonnage now classed as under construction, leaves us with less than 1,208,000 tons upon which work is actually in progress. This, it may be remarked, is 682,000 tons, or 36 per cent., less than the average figure for the four quarters immediately preceding the war, this figure being 1,890,000 tons.

The tonnage launched during the June quarter amounted to 239,373, which is a little higher than the figure of 228,371 tons for the March quarter. Of more importance, from the point of view of the immediate future of the industry, is, however, the tonnage of vessels commenced. In this respect the June quarter compares unfavourably with the March quarter, the figures being 241,283 tons and 355,203 tons, respectively. The work put in hand during the June quarter is thus 113,920 tons less than that commenced in the previous quarter, the difference amounting to 32 per cent. of the total for the March quarter. The tonnage commenced during the last quarter, it may be added, constitutes only 16 per cent. of the work in hand on March 31.

The tonnage now building in Great Britain and Ireland comprises 334 vessels, of which 267, making 1,111,000 tons, are steamers, 48, with an aggregate tonnage of 221,274, are motor vessels, while the remainder consists of 19 sailing ships and barges, which only account for 5,485 tons between them. With regard to motor ships, it is interesting to note that the tonnage of this class of vessel under construction has increased during the past year from 129,134 at the end of June, 1922, to the figure given above, the difference of 92,140 tons being an increase of over 71 per cent. Two of the motor ships now building are large vessels, one exceeding 20,000 tons and the other exceeding 15,000 tons. Of the large steamers now building, 6 are of over 10,000 tons and under 12,000 tons, 5 of over 12,000 tons and under 15,000 tons, 6 of over 15,000 tons and under 20,000 tons, 6 of over 20,000 tons and under 25,000 tons, while one vessel exceeds the last-mentioned figure. The tanker tonnage in hand has declined during the quarter from 137,520 at the end of March to 102,836 on June 30, and these figures, it should be explained, do not include vessels of less than 1,000 tons.

As would be anticipated from the total figures given above, the work in hand at most of the important shipbuilding centres of the country has declined during the quarter under consideration; Sunderland and Barrow are the only noteworthy exceptions in this respect. For Glasgow the figures for the ends of the March and June quarters are 368,272 tons and 312,624 tons respectively, while those for the other Clyde ports, Greenock, &c., are 164,455 tons and 159,510 tons. At Newcastle the work in hand has fallen off from 276,781 tons to 222,652 tons, while at Belfast there has been a reduction from 209,770 tons to 201,970 tons. Sunderland, as previously mentioned, is an exception to the general rule, and the work in hand there has increased from 119,753 tons on March 31st to 127,495 tons on June 30th. The only other districts with over 20,000 tons of shipbuilding work in hand are Middlesbrough, 72,513 tons; Barrow, 60,950 tons; Liverpool, 46,174 tons; Hartlepool, 31,127 tons; Hull, 30,548 tons; and Dundee, 20,400 tons. At Barrow the figure given exceeds that for the March quarter by 14,250 tons, but in all other case s just referred to the March figures were higher.

The position of the foreign shipbuilding industry is apparently very similar to that of this country. The vessels building abroad now number 431 and have a total tonnage of 1,206,097, as compared with 448 vessels and 1,367,934 tons at the end of the March quarter and with 476 vessels and 1,315,926 tons a year ago. The tonnage reduction in foreign shipbuilding work thus amounts to nearly 12 per cent. for the quarter and to over 8 per cent. for the year. Work has been suspended on a rather larger proportion of the foreign tonnage classed as under construction than of that so classified in this country, the actual figures for the former being approximately 132,000 tons; work is therefore actually proceeding on about 1,074,000 tons of shipping in foreign yards.

Germany now takes second place among the shipbuilding nations of the world, that country now having 301,199 tons of merchant shipping under construction. This figure, which is lower than that for the March quarter, represents nearly 12 per cent. of the shipbuilding work of the whole world and 25 per cent. of the foreign shipbuilding work. A great development has also taken place during the quarter in the shipbuilding work in hand at Danzig, which has risen from 9,600 tons to 51,206 tons. The tonnage under construction in French yards has decreased from 209,581 to 170,866 during the quarter, the current figure representing 14 per cent. of the total foreign work. Italian shipbuilding work has fallen off from 185,000 tons at the end of the March quarter to 141,543 tons on June 30. The other important items in the total, given in order of magnitude, are: United States, 133,660 tons; Holland, 99,821 tons; Japan, 72,767 tons; Sweden, 49,329 tons; British Dominions, 45,201 tons; Denmark, 44,496 tons; Spain, 44,337 tons; and Norway, 30,030 tons. In most cases the current figures are lower than those for the end of the March quarter, the only exceptions being Sweden and the British Dominions. To the total for the latter, 23,000 tons is contributed by Australia, 13,500 tons by Hong Kong, 5,221 tons by Canada, and the remaining 3,480 tons by other Dominions. The increase in the total figure, however, is less than 200 tons, increased activity in Australia and other Dominions being nearly balanced by a reduction of the work in hand in Canadian yards; the figure for Hong Kong has not altered during the period under review.

The total tonnage now building abroad includes 304 steamers, of 1,025,924 tons in the aggregate, 83 motor ships, making 166,662 tons together, and 44 sailing vessels and barges with a total tonnage of 13,511. Of the motor vessels in hand, Germany is building 15, which account for 46,330 tons, Sweden

11, making 37,085 tons, the United States 10, making 24,245 tons, Denmark 6, with an aggregate tonnage of 22,350, and Italy 15, making 16,533 tons. With the 221,274 tons of motorships which, as previously mentioned, are under construction in Great Britain and Ireland, the tonnage of motor ships now building in the whole world amounts to 387,936, and represents over 15 per cent. of all the shipbuilding work in hand. Tankers of over 1,000 tons each now building abroad have an aggregate tonnage of 76,944, and this, added to the tanker tonnage in hand in British and Irish yards, gives a total for the whole world of 179,780 tons. The latter figure may be compared with those for June, 1922, and for March last, which were 529,911 tons and 247,793, tons respectively, and the comparison seems to indicate that the world's requirements for this class of tonnage, for the time being, have been practically met. Of the 17 vessels building abroad of over 10,000 tons each, 3 exceed 20,000 tons, and, of the latter, one is building at Danzig and one each in Germany and Italy.

In conclusion, we may remind our readers that the statistics compiled by Lloyds' Register, from which the figures given above have been extracted, do not include vessels of less than 100 gross tons, and that gross tonnages are referred to in all cases. We may also mention that, of the world's total, 366 ships, making 1,318,505 tons in all, are being constructed under the inspection of Lloyds' surveyors with a view to classification in the Society's Register Book. The corresponding figures for Great Britain and Ireland alone are 268 ships and 1,016,490 tons, the tonnage representing 76 per cent. of the total now building in the British Isles.

ECONOMIC AND FINANCIAL CONDITIONS IN GERMANY.

THERE is, perhaps, no single factor in the equation of European stability of more vital moment than that which is introduced by the present financial and economic position of Germany, nor is there any other factor the analysis of which presents such bewildering difficulty. That the free flow of international trade is dependent upon the existence of stability, or at least a condition approaching stability, in international exchange, is a basic principle of economics, and for this reason the present financial position in Germany is of paramount importance not only to Germany herself but to the rest of the civilised world. When the currency of a great nation such as Germany, with a huge industrial population, a normally extensive overseas trade and great interests in foreign countries, becomes practically valueless when put into terms of other currencies, the event is bound to react upon the commerce of other nations and effect detrimentally the general flow of trade.

The German mark has depreciated in value from 242·47 to the pound in 1921 to a value which fluctuates uncertainly between 800,000 and 1,200,000 to the pound. Just how much of the inflation reflected in these figures has been due to the demands on the national finances involved by the reparation payments which have been made, how much to recent events in the Ruhr, and how much to deliberate manipulation it is impossible to determine from the data available. The fact, however, remains, that at the present time the mark is practically valueless, and for this reason the industrial and economic future of Germany must, for the time being, remain a matter of conjecture.

Prior to the recent utter collapse of the mark on the world's exchanges its depreciation was not without its advantages to German industry. It reduced the cost of production as compared with that of other competing countries, the export trade in manufactured articles being thereby stimulated, while domestic buying was directly encouraged by the unchecked decline in the value of the mark. People in Germany preferred the possession of things to the ownership of paper marks, the value of which was slumping rapidly towards zero, and as a result buying was stimulated. As a consequence of these conditions industry has, on the whole, been experiencing a period of considerable activity, and there has been no serious unemployment. The fact that Germany has been, until recently, largely independent of foreign countries as regards raw materials for her industries and food-stuffs for her population, has rendered this rather curious state of affairs a matter of practical possibility. At present, however, these conditions no longer prevail. With a currency which has become practically valueless and the natural resources of the Ruhr district no longer available, the whole aspect of the industrial position has been entirely altered, and it is very hard to see how, under present circumstances, the productivity of German industry can be maintained.

It is pretty generally conceded that, in order to return to a state of healthy commercial and industrial activity as distinct from the activity engendered by the stimulant of a depreciating currency, the first step Germany must take is to stabilise her monetary unit at a level at which its value will have a real meaning on international exchanges. To this end the establishment of a new standard of value has been glibly suggested. But how, under existing circumstances and with the present huge note circulation, any such standard is to be established is not clear. The only practical solution of the problem would appear to be a drastic reduction in Governmental and municipal expenditure, and a considerable increase in industrial productivity and in export trade. The first of these conditions depends to a large extent on the German Government itself, and to a less extent upon a satisfactory settlement of the vexed question of reparations, while the second must, in the nature of things, be largely dependent upon the course of events in the Ruhr. But until such matters as the payment of reparations by Germany and the future of the territories recently occupied by the French are definitely settled no idea concerning the future of German industry can be formed.

In spite, however, of the fact that recent events have altered the entire situation, a review of some of the leading features of German industry during the past year may not be without interest, particularly in view of the fact that a return to conditions approximating to those then existing is by no means impossible. With regard to the iron and steel trade we have, in Germany, an industry of much the same size as that of the United Kingdom, and placed in much the same position in respect to the supply of raw materials. That the industry has been working throughout the year at very nearly full pressure, that the majority of its furnaces have been in blast and its steel works well occupied is evident from the report of the Department of Overseas Trade on the economic and industrial conditions in Germany during the year 1922. The figures given in this report are illuminating, and reflect a degree of activity in the German iron and steel industries greatly in excess of that which has been in evidence in this and in other countries the currencies of which have been maintained at a reasonably high level of value. During 1922 imports of iron ore and of manufactured products of the iron, steel and engineering industries were, speaking generally, in excess of the average imports during the period immediately before the war; and although exports have been considerably lower owing to the domestic demand for engineering products, the industries in question have experienced an activity which is in striking contrast to that which has been characteristic of these industries in other countries. As regards iron ore, the importations during the first ten months of 1922 averaged 927,600 metric tons, as compared with a monthly average of 1,168,600 tons in 1913, a decrease of only about 20 per cent. As against this the imports of pig-scrap and semi-products rose from a monthly average of 39,300 tons in 1913 to 101,500 tons in 1922, while the importations of manufactured iron and steel products (pipes, bar iron, plates, machinery, &c.), increased from a monthly average of 21,200 tons in 1913, to 94,550 tons during the first ten months of 1922. The average monthly increase in the importations of bar iron and shapes was very pronounced, the average for 1913 being only 2,100 tons as compared with 59,500 tons for the first nine months of 1922 and 104,300 tons during the month of October. As regards exports, the figures for last year are in all cases very much lower than the average figures of the pre-war period, particularly as regards iron ore, the average monthly exportation in this case having fallen from 217,700 tons in 1913 to 11,400 tons. Pig-iron, scrap and semi-products were also exported to a much more restricted extent than before the war, the figures being 146,100 tons per month in 1913, as compared with 25,900 tons per month for the first ten months of 1922. In the case of manufactured products of the iron and steel industries the average monthly exportations showed a diminution of approximately 220,000 tons, the figures being 445,000 tons in 1913 and 225,000 tons in 1922.

The increase in imports and decrease in exports reflected in these figures is an indication of the greatly increased domestic consumption of iron and steel products in Germany as compared with the pre-war consumption. This increase has probably been due to two principal causes: The sustained depreciation in the value of the mark, which induced manufacturers to put all surplus capital and all available earnings into new plant or additional stores of raw material rather than into a capital reserve, the value of which was almost certain to depreciate; and the legitimate necessity of plant renewals to replace that which had become depreciated or obsolete during the war. Both these causes have now, to a large extent, become inoperative, the first owing to the fact that the mark has now reached a level at which any further depreciation will be, for all practical purposes, insignificant, and the second owing to the fact that the demand for renewals created by the war has been largely satisfied. In view of these facts, and of the situation in the Ruhr, it would seem that less active conditions would prevail in the iron and steel industries for some time to come, but the present financial position of Germany is so unprecedented that the actual results of her depreciated currency on the industries of the country are difficult to estimate, while the alleged wealth of her industrialists in foreign currencies and securities may, if it is as great as has been stated, materially affect the situation.

The position with regard to coal production is difficult to compare with that which existed before and during the war. By the provisions of the Peace Treaty, Germany lost the Lorraine coalfield, with an annual production of nearly 4,000,000 metric tons, and about 75 per cent. of Upper Silesian coalfield, the pre-war output of which was over 40,000,000 tons. The Aix-la-Chapelle field lies in Occupied Territory, and can, therefore, be used only at the discretion of the occupying powers, and the Ruhr, with its annual output of over 100,000,000 metric tons, is at present in the same position. Germany has thus at her free disposal only a part of the Upper Silesian production, the Lower Silesian production, and the output of the Saxon mines, a total of about 18,500,000 metric tons per annum, against an estimated consumption of 163,621,000 metric tons in 1922. The dependence of German industries on the Ruhr coal supply is therefore evident. Under present circumstances, with this source of supply no longer available, it is inevitable that Germany will require to purchase heavily from other countries, and from the position of being able to export an annual surplus of approximately 26,000,000 metric tons will, under present conditions, be compelled to import coal to the extent of something like 145,000,000 metric tons annually, in order to maintain her industrial activity at its pre-war level. This in itself, is bound to be a serious handicap which can only be mitigated to a limited extent by more economical methods and improved organisation.

BRAZILIAN COAL.—The Central Railway of Brazil, owned by Government, have lately obtained satisfactory results in the use of national coal as fuel in their goods transport service, and, consequently, have increased their purchases from 12,000 tons to 32,000 tons per annum. It is understood, says the London and River Plate Bank, Limited, that the Minister of Transport is favourable to the policy of using national coal on all Government lines, so far as supplies will permit, and he has authorised the Director of the Central Railway to acquire special locomotives suitable for burning this mineral. Although national coal costs approximately only one-fifth of that imported, its calorific value is much inferior, and some 68 per cent. more of the national product is required for a train to cover 1 mile than is needed when using British or American coal. Even so, a very considerable economy should be effected by employing the Brazilian commodity, and this fact is becoming a further encouragement in the development of the mining industry in Rio Grande do Sul.

THE ROYAL AGRICULTURAL SHOW AT NEWCASTLE.

(*Concluded from page* 13.)

MESSRS. ROBEY AND CO., LIMITED, of Lincoln, showed vertical two-stroke hot bulb crude-oil engines up to 30 brake horse-power, but their main exhibits are connected with steam. Small stationary steam engines both vertical and horizontal, were on the stand, in addition to a scale model of a uniflow engine operated by air from a compressor which also formed one of the exhibits. Messrs. Robey and Co. were one of the firms showing portable steam engines, their example being unusual in that the engine was totally enclosed in a cast-iron casing, access being provided by means of bolted covers on the top, as shown in Fig. 8, annexed. The eccentric and rod driving the feed-pump were similarly enclosed so that all moving parts were thoroughly protected from dust and grit. Splash lubrication is provided and the crank-shaft runs in ball bearings. A steam road roller and a steam tractor were also shown, but the six-wheeled steam wagon, illustrated in Fig. 9 on this page, was one of the most prominent exhibits. This wagon has been designed to replace the ordinary wagon and trailer, the speed of which is limited to 5 m.p.h. The new vehicle may legally travel at 12 m.p.h., and as it will carry the same load as the other combination, namely, 10 tons, its advantages are obvious. The engine and boiler are similar to those used in the firm's steam wagons, the engine being of the two-cylinder compound type and the boiler having a circular firebox free from stays either at the sides or on the crown. The carrier platform rests on a turntable over the driving axle, so that ample flexibility is provided for turning corners. There are two road-speeds, of 6 and 12 m.p.h. respectively, and independent foot brakes are fitted to intermediate and rear wheels. The water tank carries 165 gallons and the bunker 4 cwts. of coal. The standard body has a platform area 20 ft. long by 7 ft. wide. It can be easily detached from the tractor if desired.

In addition to the exhibits of Messrs. Ruston and Hornsby, Limited, of Lincoln, which we referred to in our previous issue, the firm showed the portable pumping set, illustrated in Fig. 10 on the opposite page. A small hopper-cooled petrol or paraffin engine is arranged to drive a vertical pump by means of a belt and reduction gearing, the reciprocating motion being obtained by a crank mechanism as shown in the illustration. The whole arrangement is mounted on a trolley, and is designed for the use of farmers or contractors who require a small portable plant for draining ditches, escavations, &c. The pumps will raise 1,700 gallons of water per hour. Should the set not be required for pumping, the engine can, of course, be belted to any other machinery within its capacity to drive. A similar plant is supplied, which contains a charcoal gas-producer mounted on the trolley to supply gas for driving the engine, thus rendering it independent of liquid fuel.

Messrs. William Foster and Co., Limited, of Lincoln, won a silver medal for an automatic stack-feeder, which by reason of its obvious labour-saving features, was one of the principal attractions among the machinery in motion. The function of the device, which is shown in Fig. 11 on the opposite page, is to convey the sheaves from the stack to the thrashing machine, cutting the bands in transit and feeding the grain evenly and steadily to the thrasher drum. In ordinary practice two men are required on a thrasher, one to cut the bands and the other to feed the machine. These men are entirely dispensed with by Messrs. Foster's device, and as the latter will take the sheaves from any level the rick may have been reduced to, the services of a further man to lift the sheaves from the rick to the top of the thrasher may also be rendered unnecessary. The Foster stack feeder consists essentially of a trough containing a canvas belt conveyor, the trough being hinged to the top of the thrashing machine so that its outer end will rest on the top of the rick from start to finish. The trough is almost completely counterbalanced by a lever and balance weights. The sheaves are pitched into the conveyor trough and are carried along it by cross-bars on the canvas. A pair of rotary knives driven by chains cut the strings as the sheaves pass under them, and behind these knives is a combing drum which secures the evenness of feeding that is so desirable in threshing operations. The combing drum is chain-driven and its teeth move much faster than the conveyor belt so that the sheaves are elongated and fed as a continuous stream. The combing drum is mounted on hinged levers and should the sheaves be delivered to it faster than it can handle them, they cause the drum to rise. The levers are connected to a clutch driving the conveyor. As soon as the drum is forced to rise, the clutch is released and the conveyor band stops, so that no more sheaves can be carried forward until the combing drum has disposed of those on which it is working. As soon as these are reduced to the proper thickness for feeding into the thrasher, the combing drum falls and the conveyor re-starts automatically. The saving of two, or more probably three, men at the thrashing machine, is a matter of very great importance indeed to farmers, as the men are rendered available for other work, of which there is always plenty to be done at thrashing times. The avoidance of heavy pitching as the stack gets lower than the thrasher saves much fatiguing labour on the part of the rick hands and the rate of thrashing has in many instances been increased by 25 per cent. or more after the feeder has been fitted. The apparatus, which weighs about 6 cwt., can be packed on top of the thrasher ready for travelling in less than two minutes. It struck us as a really important advance in thrashing machinery and well worthy of the award which it obtained.

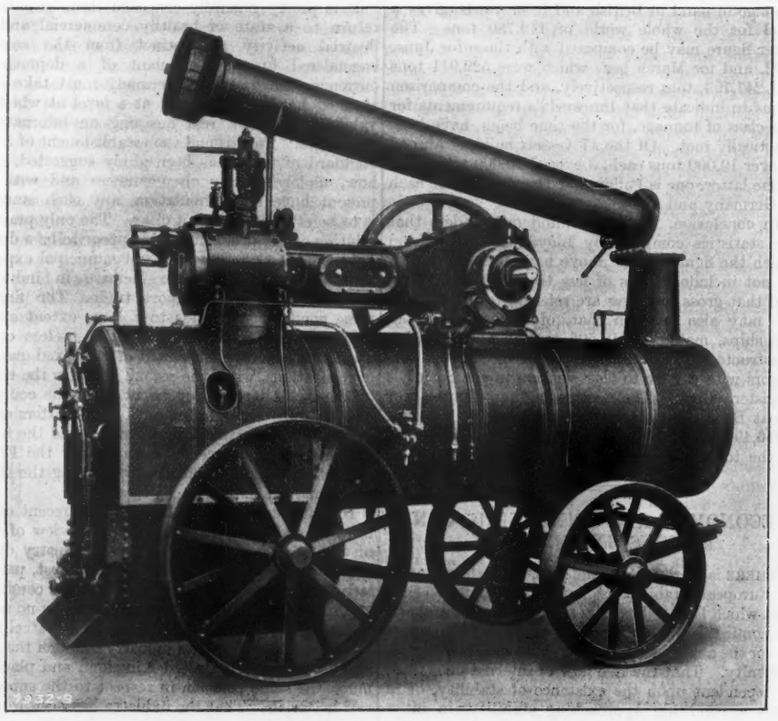

FIG. 8. ENCLOSED PORTABLE STEAM ENGINE; ROBEY AND CO., LIMITED, LINCOLN.

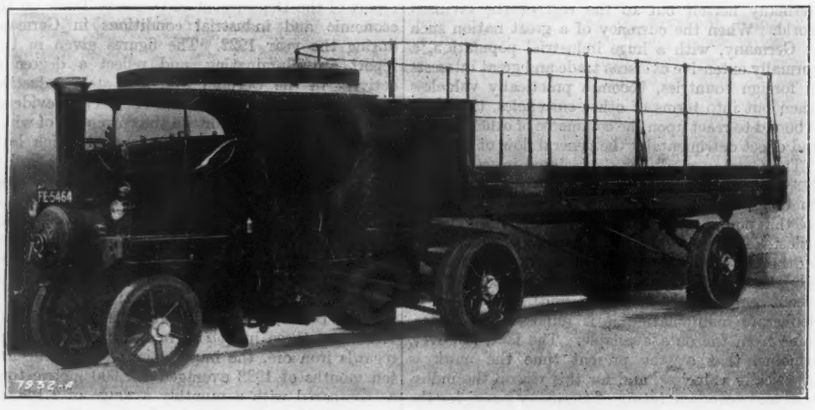

FIG. 9. SIX-WHEEL STEAM WAGON; ROBEY AND CO., LIMITED, LINCOLN.

Another piece of apparatus which earned the Society's silver medal was the cold-starting device for hot bulb oil engines exhibited by Messrs. Petters, Limited, and referred to in our last issue. We give in Fig. 12, on the opposite page, a small sectional view of the head of one of these engines showing the apparatus in position. The device consists of a cartridge of inflammable material which is inserted in the hollow plug screwed into the cylinder head. Before the plug containing the cartridge is put into position the cartridge is lighted by a match. The heat generated by its combustion is sufficient to raise the hot-bulb to the temperature required to ignite the fuel charge, so that the engine will start at once without the usual services of a

blow lamp or any electric pre-heating apparatus. The cartridge is safe and non-explosive. We are informed that the device has just received a diploma of honour in the Brazilian Centenary Exhibition.

Messrs. Sir W. G. Armstrong, Whitworth and Co., Ltd., of 8, Great George-street, Westminster, who have quite recently taken up the manufacture of road-making machinery at their Openshaw works, exhibited a steam road roller normally of the 10-ton size, but weighing actually about 14 tons on working order. The engine is of the compound type with cylinders 4·75 in. and 7·25 in. diameter by 10 in. stroke, fitted with piston valves which are driven through the ordinary Stephenson link motion. The boiler, which works at a pressure of 180 lb. per square inch, has a total heating surface of 82·5 sq. ft. and contains a Belpaire fire-box directly stayed at the crown and sides. In general appearance the roller presents no unusual features. The fork, however, which carries the front rollers is made of cast steel instead of the more usual cast iron, and the rollers, both back and front, are built up with dished steelplates forming the connection between the boss and the rim. There are thus no spokes to become loose or broken, and a source of trouble sometimes met with in the older types of rollers has been eliminated. The front roller wheels are 45 in. in diameter by 25 in. wide and the driving rollers 63 in. diameter by 16 in. wide. The machine has a wheel base of 11 ft. $\frac{3}{4}$ in. and rolls a width of 6 ft. 6$\frac{1}{2}$ in.

Messrs. Sir W. G. Armstrong, Whitworth and Co., Limited, also showed a new type of coal-cutting machine, a somewhat unexpected article to meet at an agricultural show. This machine, known as the "Strong-arm" coal getter, is also a new production of the company. We illustrate it in Fig. 13, page 56. The central pillar is of heavy steel tubing, with a jack screw at the top for fixing the machine between the floor and roof of the mine. The cutter-bar is operated pneumatically exactly like a rock-drill. It is carried in a cradle along which it is fed forward by means of a feed screw turned by a small 4-cylinder Vee-type reversible air motor at the back of the cradle. Horizontal and vertical quadrants with worm-gear permit the cutter to be swung to and fro in any plane when working, and the whole apparatus can be raised or lowered on the pillar by means of a grooved spiral face cam engaging with teeth on the pillar. The air supply to the cutter is independent of that to the feed motor, so that the machine is completely under control and the operator can make all movements without shifting his position. We understand that the machine has proved highly successful in some of the Durham collieries, the output per man being greater than when "shot-firing" and comparing favourably with that obtained by any kind of mechanical coal cutter. Numerous small vertical oil engines and pneumatic tools were also exhibited by Messrs. Armstrong-Whitworth.

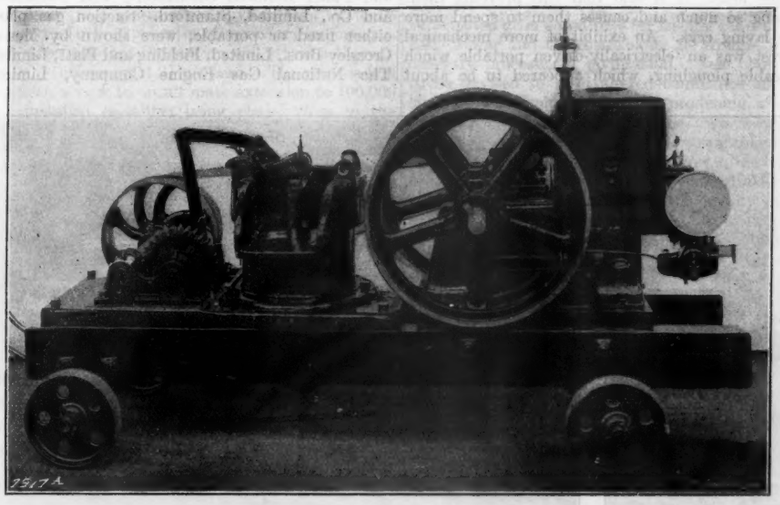

FIG. 10. PORTABLE OIL ENGINE AND PUMP; MESSRS. RUSTON AND HORNSBY, LIMITED, LINCOLN.

FIG. 11. STACK FEEDER; MESSRS. WILLIAM FOSTER AND CO., LIMITED, LINCOLN.

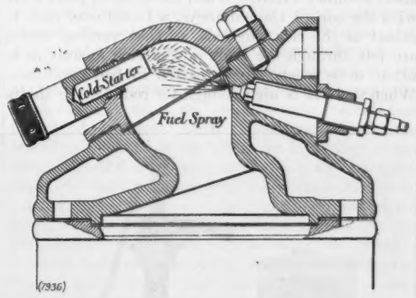

FIG. 12. OIL ENGINE STARTING DEVICE; MESSRS. PETTERS, LIMITED, YEOVIL.

Messrs. Joseph Booth and Bros., Limited, of the Union Foundry, Rodley, near Leeds, exhibited the electric locomotive and the rubber-tyred electric truck illustrated respectively in Figs. 14 and 15, page 56. They are both battery-driven vehicles. The former is particularly designed for mine service. It weighs 2$\frac{1}{4}$ tons and has an overall height of 3 ft. 6 in., the extreme width being about 15 in. greater than the gauge of the track on which it runs. The length over buffers is 7 ft. 6 in., the wheel base 2 ft. 3 in., and the wheel diameter 16 in. The battery, which is either of the lead-plate or nickel-iron type as desired, has a capacity of 193 ampere hours and takes 15 k.w.h. at a charge which will provide from 150 ton miles to 200 ton miles of haulage. A totally enclosed series wound motor with a continuous rating of 2·5 b.h.p. drives both axles by means of worm gear. Hoffmann ball bearings are fitted throughout. The locomotive will give a drawbar pull ranging from 600 lb. at 2 m.p.h. to 200 lbs. at 5 m.p.h. It will do the work of from six to nine ponies in a mine, with a great saving in labour cost and an increase of cleanliness in the pits. The electric truck, shown in Fig. 15, will take a load of 2 tons per 5 m.p.h. on a good level road. The platform is 7 ft. long by 3 ft. 6 in. wide, and is 2 ft. above ground level. The battery is slung beneath, giving a ground clearance of 5 in. The driver stands on a small front platform which can be folded up when the truck has to stand in a confined space. The steering tiller is at his right hand, and the lever working the controller at his left. The controller is of the drum type with magnetic blow-out, giving three speeds in either direction. The brake operates on a drum on the high-speed worm shaft. It is spring controlled and is normally on. It is interlocked with a quick-break switch in the motor controller, which cuts off the motor current immediately before the brake is applied, and prevents the current being put on again until the brake is released and the controller returned to its neutral position. The battery contains 20 cells of 161 ampere-hour capacity. A four-pole totally enclosed reversible series-wound motor drives the back axle through a cardan shaft and differential gear. The motor is rated at 2·5 b.h.p. continuously, but will develop 7 b.h.p. intermittently. The wheels are all 20 in. diam. with 2$\frac{1}{4}$ in. rubber tyres, the front wheels having Ackerman steering, pivoted immediately over the treads. Ball bearings are used throughout the vehicle.

The stand of Mr. R. Borlase Matthews, of Greater Felcourt, East Grinstead, Sussex, was unique of its kind, for the appliances shown were taken from the exhibitor's own farm for the purpose of demonstrating how electric power can be profitably employed by the farmer. Fortunately in no instance was any external supply of electricity essential to the operations, which could, indeed, be

carried out without the use of electricity at all, although electric power was certainly convenient for them. On his own farm Mr. Matthews is superseding the immemorial method of making hay by procedure which renders him independent of weather conditions. The grass is cut in full flower and twenty-four hours afterwards is made into a rick of the usual size. The rick is built on a site in which from one to three trenches have been cut and covered with planking. At certain points along each trench a hole is cut in the planking and a short chimney fitted. When the grass is piled level with the top of the chimneys, a barrel over each is raised as the rick proceeds, so that vertical shafts are left through the body of the rick exactly as is often done when hay is carted in bad condition. When the rick is high enough for roofing, the shafts are closed by sticks or brushwood laid across them and the roof is made without shafts.

A rick made with green or wet grass in the ordinary way will, of course, heat violently and even take fire. To the trenches below his ricks (Mr. Matthews connects a Sirocco fan, and as soon as the temperature rises to about 150 deg. F., depending on the class of hay required, he blows air through the rick by means of the fan until the temperature is reduced to about 120 deg. F. Thermometer tubes inserted into the rick enable the temperature at any point to be ascertained. The first heating takes place in the lower layers, and after these have been cooled heating starts further up and so on. The temperature is kept under control by the air until the whole rick is completely "cured" into hay. We were assured that grass has been cut and immediately carried in pouring rain, and the resulting hay has been indistinguishable from the best ordinary hay. For a large rick the fan would require about 5 b.h.p. A three hours' blow is usually sufficient to dry the rick and suppress the first heating, and, after that, blowing is carried out for an hour a day for the next nine days. In three weeks' time a final two hours' blow completes the operation. No trouble is said to be experienced with mould or mildew if the air shafts are properly made and situated in the rick. A stack of green rye grass was shown at Newcastle in course of treatment, but the time was only sufficient to show that it appeared to remain sweet and cool in the interior.

Another exhibit of Mr. Matthews was an incubator containing 2,300 eggs in numerous superposed trays, this being rendered practicable by the circulation of hot air by a fan. The trays are suspended by vertical rods at their corners and can be instantaneously tilted simultaneously to turn the eggs over. The incubator is a small continuous-process chicken factory, eggs being put in twice a week and hatched chickens removed at the same time. A further exhibit connected with poultry farming was a cheaply constructed fowl house, provided with an electric lamp controlled by a time switch, so that an hour's extra illumination at the beginning and end of each day was provided for the hens. It is said that this prevents them sleeping so much and causes them to spend more time laying eggs. An exhibit of more mechanical interest was an electrically-driven portable winch for cable ploughing, which appeared to be about as simple and cheap an application of power to ploughing as could be devised.

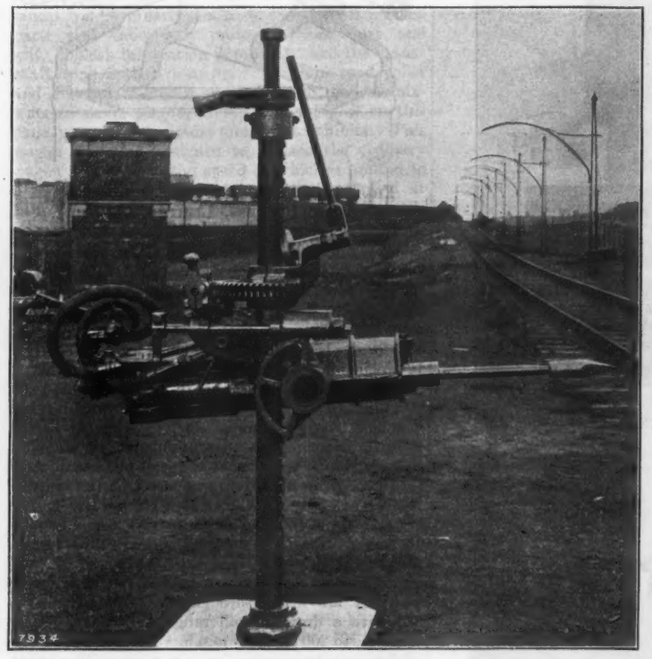

FIG. 13. PNEUMATIC COAL-CUTTER; SIR W. G. ARMSTRONG, WHITWORTH AND CO., LIMITED.

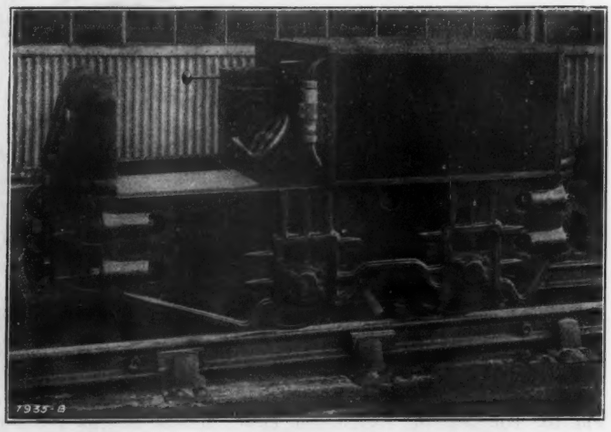

FIG. 14. ELECTRIC LOCOMOTIVE; JOSEPH BOOTH AND BROS., LIMITED.

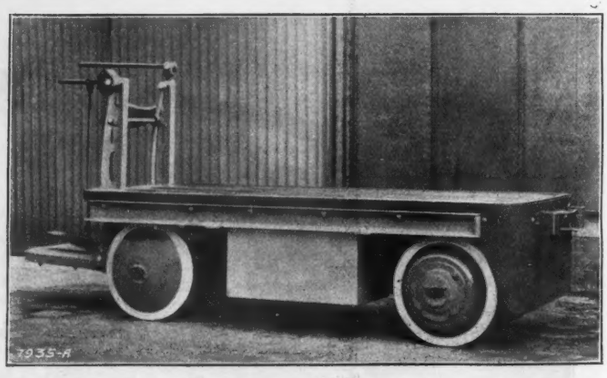

FIG. 15. ELECTRIC TRUCK; JOSEPH BOOTH AND BROS., LIMITED.

As at all shows of this nature, there were at Newcastle many exhibits, some of them very imposing, of machinery which is so standardised by the various makers that detailed reference to the stands is unnecessary. Messrs. Ruston and Hornsby, Limited, Lincoln; Marshall, Sons and Co., Limited, Gainsborough; Clayton and Shuttleworth, Limited, Lincoln; Robey and Co., Limited, Lincoln; William Foster and Co., Limited, Lincoln; John Fowler and Co., Limited, Leeds; Richard Garrett and Sons, Limited, Leiston; Aveling and Porter, Limited, Rochester; W. Tasker and Sons, Limited, Andover; J. and H. McLaren, Limited, Leeds; Ransomes, Sims and Jefferies, Limited, Ipswich; and Charles Burrell and Sons, Limited, Thetford, all showed traction engines, and many of these firms showed also steam wagons, thrashing machinery, road rollers and other machinery with which their names are so closely associated. The auto-horse, a rubber-tyred single-wheeled attachment for hauling about and placing ordinary lorries, was again to be seen on Messrs. W. Tasker and Sons stand performing really wonderful evolutions on a small platform. We illustrated this machine last year. Messrs. Ransomes, Sims and Jefferies, Limited, exhibited their 15 cwt. electric runabout crane which will rotate in its own space. This also we have illustrated and described. Messrs. John Fowler and Co., Ltd., and J. and H. McLaren, Limited, both showed motor cable ploughing tackle, while steel ropes for the same, and indeed for practically every other, purpose were exhibited by Messrs. George Cradock and Co., Limited.

Oil engines of the larger sizes were exhibited by Messrs. Vickers-Petters, Limited, Ipswich; Robey and Co., Limited, Marshall, Sons and Co., Limited, Ruston and Hornsby, Limited, Clayton and Shuttleworth, Limited, Crossley Brothers, Limited, Manchester; Tangyes, Limited, Birmingham; Fielding and Platt, Limited, Gloucester; and Blackstone and Co., Limited, Stamford. Suction gas plant, either fixed or portable, were shown by Messrs. Crossley Bros., Limited, Fielding and Platt, Limited. The National Gas Engine Company, Limited, Ashton-under-Lyne, and Ruston and Hornsby, Limited, while among the innumerable makes of small internal combustion engines, the exhibits of Messrs. Petters, Limited, and R. A. Lister and Co., Limited, of Dursley, deserve mention. Windmills were shown by six firms, namely, John S. Millar and Sons, Annan, Dumfriesshire; McBain Brothers, Limited, Berwick-on-Tweed; E. and H. Roberts, Limited, Stony Stratford; Thomas and Sons, Limited, Worcester; Lloyds and Co., Ltd., Letchworth; and John McBain and Son, Chirnside, Berwickshire.

NOTES.

OPENING OF NEW POWER STATION FOR EDINBURGH.

ON Wednesday last the new power station of the Edinburgh Corporation, situated at Portobello, on the Firth of Forth, was formally opened by the King. The new station contains three 10,000-kw., 6,600-volt, three-phase 50-cycle turbo-alternators of Messrs. Brown, Boveri and Co.'s manufacture, fitted with Allen's condensing plant and six Stirling

boilers with superposed steel economisers. The boilers deliver steam at 300 lb. per square inch superheated to 700 deg. F., two boilers being capable of supplying each of the turbines. Very elaborate means have been provided for controlling the operation of the boilers, each boiler being fitted with indicating and recording instruments to enable its efficiency and performance to be constantly under the supervision of the boiler-house attendant. The vital measurements of the quantity of coal burnt per shift and the quantity of water evaporated are provided for by means of Lea coal meters, water meters and steam flow meters, and in addition there are the usual CO_2 instruments, pyrometers, draughts gauges and other apparatus of secondary importance. It is expected that the station will attain a thermodynamic efficiency of 21 per cent. The plant is laid out with a view to an ultimate extension to 100,000 kw. installed capacity, being placed close to the Firth of Forth it has admirable condensing facilities. The switch gear which is of the cellular type with motor-controlled spring-operated switches, has been supplied by the British Thomson-Houston Company, Limited, the switch-house is adjacent to the turbine room and its topmost floor contains the remote control boards, the low-tension panels for the station auxiliaries and the local traction feeders. The operating room gives access to a gallery commanding a view of the whole turbine room. The high-tension bus-bars are in duplicate, as are also the generator switches and the principal trunk feeder switches. Each set of main bars is subdivided into four sections from which trunk feeders of 5,000 k.v.a. capacity run to the various substations, one of which is in the building itself. Switch-gear of a similar type is now on order to accommodate 10,000-k.v.a. feeders to serve transformers stepping up to 33,000 volts for long distance transmission. The consulting engineers for the station are Messrs. Kennedy and Donkin, of London.

The Determination of Stresses by Experiments on Models.

It is very many years since the late Sir Benjamin Baker proposed to determine the reactions in continuous girders by means of experiments on a model. If our memory serves us, he claimed that it was quite possible to detect in this way the difference in the reaction which would be caused by the presence or absence of the driver on the footplate of a locomotive. The growing popularity of ferro-concrete has led to the erection of many structures in which the degree of indeterminateness far exceeds that characteristic of a continuous girder. In view of the laborious character of the calculations thus involved, Professor G. E. Beggs, of Princeton University has accordingly worked out a method of determining the stresses in such structures which is to some extent analogous to Baker's. This is described in a recent issue of the *Scientific American*. Taking for example a viaduct of three arches, a model is made from a paper board of high quality, $\frac{1}{8}$ in. thick. This model is laid horizontally on a drawing board. At foundation level it is firmly held in adjustable clamps, whilst elsewhere it rests on steel bicycle balls so that it can alter its form with a minimum of friction. Having secured it in position and in its normal undistorted and unloaded form, the effect of various systems of loading is determined as follows: Suppose the figure sought is the reaction at the foundation level of the second pier, due to a load applied at the crown of the arch. To determine this the foundation at the second pier is moved vertically through a space of $\frac{1}{10}$ in., special gauges being provided to this end. By means of a microscope the corresponding deflection produced at the crown is measured and is found to be, say, 0·047 in. Then by Lord Rayleigh's principle, the ratio of the reaction at the abutment to the load applied at the crown will be in inverse ratio to the two deflections. In this way, by measuring the deflections at a number of points, due to a definite displacement impressed on each foundation in turn, the corresponding reactions can be quickly determined, and once these are known the stresses due to any loading can be found. The application of the method to cases in which there are bending moments at foundation level, as well as vertical reactions, is not described in our contemporary.

LITERATURE.

The British Coal-Mining Industry during the War. By Sir R. A. S. REDMAYNE, K.C.B., M.Sc. Publications of the Carnegie Endowment for International Peace. Oxford: The Clarendon Press. Humphrey Milford. 1923. [Price 10s. 6d. net.]

THE Directorate of the Division of Economics and History connected with the Carnegie Endowment for promoting international peace had prepared elaborate plans for studying the effects of war on modern life, when the outbreak of hostilities in 1914 rudely brushed away the proposed scheme and substituted grim actualities for tracing the economic cost of war and the disturbance it wrought in the ordinary processes of civilisation. New plans had to be devised to meet altered conditions and the later project took the form of producing a series of monographs, written by those who were well qualified for the task, either from having taken part in the conduct of affairs, or, as close observers in privileged positions, could give authoritative information concerning the economic history of the different phases of the Great War and of its effect upon society. Under this plan, every volume will have a distinct value as the deliberate expression of informed opinion, independent of that derived from its place in an organised scheme. It should be possible to trace the birth and progress of projects that were devised to meet urgent conditions and were subsequently developed under the stern discipline of compelling necessity. But it may not be equally easy to see the mutual relations and reactions of simultaneously operating schemes, or the total effects of all the varying forces which were modifying each other, while shaping and controlling the industrial activities of the countries affected by the war. To construct a complete panorama of the industrial situation that prevailed can be undertaken only when time has developed the full consequences of measures, whose operations could not be foreseen, and has arranged the tangled threads of events into a clear and harmonious picture.

The subject of this volume is Coal, with the possible exception of agriculture, our greatest industry, and certainly our greatest asset. It is as Mr. Lloyd-George reminded the first great National Mining Conference, the most important element in the industrial life of the country. "It enters into every article of consumption and utility; it is our international coinage. When we buy goods, food and raw material abroad, we pay, not in gold, but in coal." Of the many uses of coal in trade, manufacture or transport, whether under ordinary conditions or in times of great emergency, few, if any, can speak with more intimate knowledge than Sir Richard Redmayne, late H.M. Chief Inspector of Mines. He was a member of all the more important committees that suggested interference with the ordinary trade channels, or devised the actual measures that sought to effect the derangement with the least possible friction. His book is therefore an authoritative collection of facts, an impartial record of events in chronological order, providing materials from which the political student of the future may construct a true representation of the conditions that obtained in the industrial situation of the time. He makes no attempt to criticise the work of others or to define his own. There is indeed little room for either. The cataclysm moved as irresistibly and as inevitably as some natural phenomenon, that human agency is powerless to change or to prevent. It may be possible to see now that some arrangements might have been made differently or more advantageously, but—

> ". . . the knowledge that the tardy morrow brings
> Impeaches not the wisdom of the act
> It came too late to guide."

So intricate and interwoven were the several policies, developing themselves in so many fields, that any programme that has not been submitted to the touch of real experience cannot be instructively compared with that actually pursued in the conduct of affairs, and declared to be superior to that which was followed. Another test, that of permanency of operation might be applied more appropriately. One might argue that if any scheme possessing merit, had been devised, it would have been adopted under ordinary peace conditions, but no plan enforced during control has been retained. Even the bold experiment of Sir G. Calthorp to effect more economical coal distribution, whose complete development would effect an annual saving of 700,000,000 ton-miles, has been allowed to lapse, perhaps because the maintenance of the scheme was found to be incompatible with complete decontrol, or to clash with the plan of grouping the railways. But in any case, the abandonment of war-time schemes does not imply any condemnation of the methods created *ad hoc*, but simply that it was unwise to disturb the established practice that controlled a business of singular complexity.

The system of control gradually enforced was an evolutionary process adapted to meet the varying needs of the moment, and the answer to critics is that it worked. It never broke down utterly under the exacting demands of our allies, or by reason of the clamorous and competing needs of home consumption. Without miners coal could not be forthcoming, but these same miners were required at the front, the coal carried to our allies withdrew tonnage from commerce, that it was necessary to preserve in some fashion to keep up our credit on neutral foreign exchanges; coal delivered to the navy reduced the domestic supply, and in this way it is easy to show that incompatible interests could not be satisfied. Of course, there was friction and discontent, and many could make suggestions that would remove the disabilities of one class by increasing the inconveniences of another. Not by such means was relief to be found.

The main events are too fresh in memory to require any explanation, but here one is reminded at first hand of the causes that led to the adoption of certain lines of policy and of the consequences that followed. The magnitude of the operations can be approximately realised, the relations with other committees, formed to promote definite interests or to diminish the effects of impending misfortune, are distinctly indicated, and the complexity of the issues involved is clearly demonstrated. In all aspects the importance of the coal industry is convincingly shown, and the results to be feared from its dislocation or failure to meet the demands made upon it faithfully depicted. The author for the most part allows the facts to speak for themselves, his comments are so few that another generation, less familiar with the facts, may from this studiously careful narration be led to underrate the momentous character of the crisis through which the country passed, particularly in the period following decontrol. To those who passed through this time, the excitement increased with each month that elapsed, leading up to the great dramatic incidents connected with the Sankey Commission. Next came the threatening attitude of the so-called "Triple Alliance," when the ranks of anarchy confronted the party of order, and the country faced ruin and disaster more closely perhaps than at any time during the Great War. Sir Richard, however, calm and detached, amidst strife and disorder, pursues the even tenour of his way, giving the impression that now he is nearing the end he is tired of his task, or does not care to revive the memory of those days. Yet he enjoyed in a sense a more independent position, for he had resigned the position of Technical Adviser to the Controller and Head of the Productive Branch and could speak with the freedom of an onlooker, unburdened with the responsibility that official authority confers.

A question that will be much debated and probably without any final satisfaction, arises concerning the expediency of Government control. Did the Government seize the opportunity to exercise supreme authority, or was the measure of complete control forced upon an unwilling executive as an unavoidable national necessity? It is clear that the author was not satisfied with the machinery that the Government eventually set up. He admits that organisation and supervision were imperative, but is of opinion that such a body as the Coal-Mining Organising Committee assisted by subsidiary Committees—an authority that was not clothed with plenary powers, but could only investigate, report and arbitrate—could have achieved the purpose of Government policy. Such Committees, familiar with the working of trade and skilled in the

management of men, could have secured an increase in output and ensured harmonious working between employers and miners. The Price of Coal (Limitation) Act was essential, in order to prevent prices rising to such a degree that the poor, being unable to purchase, would suffer disproportionately. Consequently rationing was a stern necessity, and here it may be said parenthetically, that the poorer classes were never better supplied with coal than during the period of enforced curtailment. But these benefits and others could have been accomplished by the committees if endowed with sufficient powers, and the worst features of the painful process of decontrol spared the country. Why then did the Government resort to the expedient of financially controlling the collieries. Without hesitation, Sir Richard declares that the extreme measure was unavoidable, because of the acute differences of opinion between the employers and workmen, respecting the wages question in the South Wales coalfield. Comparative peace and harmony reigned in the other coalfields. "Wales was ever the industrial storm centre . . .", but the Government could not have controlled the mines in one coalfield to the exclusion of the others." Considering the efforts made by Government through the committees to secure co-operation between the coal owners and miners by means of their own existing organisations, it is evident that the Government adopted the scheme of complete control with reluctance, each forward step being the consequence of pressure from without, and the friction and distrust that existed within, the coal-producing area. The feud that arose in 1916, continually fomented by interested partizans, is responsible for much of the disastrous conflict that marked the period of decontrol. Certainly, economy did not dictate the policy of the Government, for Sir Richard, in speaking of the gains and drawbacks of nationalisation maintains that *public management has no genius* for either efficiency or economy.

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Die Walzwerke Einrichtung und Betreib. By Dipl.-Ing. A. HOLVERSCHEID. Berlin and Leipzig: Walter de Gruyter and Co. [Price 1*s.*]

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Timothy Hackworth and the Locomotive. By ROBERT YOUNG, M.I.Mech.E. London: The Locomotive Publishing Company, Limited. [Price 21*s.* net.]

A.C. Protective Systems and Gear. By J. HENDERSON, B.Sc., and C. W. MARSHALL, B.Sc. London: Sir Isaac Pitman and Son, Limited. [Price 2*s.* 6*d.* net.]

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L'Electrodynamique des Milieux Isotropes en repos d'après Helmholtz et Duhem. By LOUIS RAY. Paris: Gauthier-Villars and Cie. [Price 10 francs.]

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Department of Scientific and Industrial Research. Fuel Research Board. Technical Paper No. 6. *Comparisons of Some Methods of Running Water-Gas Plants.* By JAMES G. KING, B.Sc., and Engineer-Captain J. FRASER SHAW, R.N. London, Manchester, Cardiff and Edinburgh: His Majesty's Stationery Office. [Price 2*s.* 2*d.* post free.]

Numerische Integration. By Dr. Fr. A. WILLERS. Berlin and Leipzig Walter de Gruyter and Co. [Price 1*s.*]

PETROLINA-THEREZINA RAILWAY, BRAZIL.—We read in a report issued by the London and River Plate Bank, Limited, that the Minister of Transport has requested his colleague at the Ministry of Finance for a report regarding the opening of a special credit in favour of the former for 2,000 contos in bonds, such sum being required for the construction of the Petrolina-Therezina Railway, linking the last-mentioned town, situated on the River Parahyba, in the State of Piauhy, with Petrolina, which is in the State of Pernambuco, on the River S. Francisco.

THE LATE MR. C. S. MEIK.

IT is with much regret that we have to record the death of Mr. Charles Scott Meik, M.Inst.C.E. and M.I.Mech.E., which took place at Ashley Gardens, London, on the 5th inst. Born on April 21, 1853, Mr. Meik had just passed his seventieth birthday. The son of Mr. Thomas Meik, of Edinburgh and London, Mr. Charles Scott Meik began his engineering career in 1870 when he entered on a three-year apprenticeship with Messrs. Hawthorne and Co., Leith. He next went to Elswick, where he spent two years, and in 1875 he took a post with Mr. J. Fox Sharp, M.Inst.C.E., the borough engineer of Hull, with whom he was engaged on numerous surveys and designs for riverside improvements, ferries and general town engineering. In 1887, he became assistant to the late Sir Thomas Bouch, and was engaged on railway and bridge work, and in particular on that engineer's designs for the Forth Bridge, which were abandoned after the Tay Bridge catastrophe. Subsequently Mr. Meik became chief designer to, and subsequently a partner in the firm of, Messrs. Thomas Meik and Sons, and during the years 1881–87 was responsible for the expenditure of nearly half a million sterling on harbour works and improvements at Burntisland, Bo'ness, Blyth, Warkworth, Eyemouth and Silloth. In the year last named the Japanese Government appointed him chief engineer for their harbours and rivers. During the subsequent three years he made comprehensive surveys and reports on the possible development and improvement of Japanese ports.

Returning home in 1890, he assisted his brother, the late Mr. P. Walker Meik, in the design of dock and harbour works in which connection special mention may be made of Port Talbot, and in 1894 a partnership was arranged between the two brothers. The firm was responsible for many important engineering works, amongst which were included the Port Talbot Docks and Railways, in which they were associated with the late Mr. T. Forster Brown, and the King's Dock, Swansea, in conjunction with Mr. A. O. Schenk. On the North-East Coast the firm carried out the improvement and extension of Seaham Harbour and constructed a new graving dock at Hebburn-on-Tyne. Messrs. Meik were also the engineers for the Kinlochleven water power scheme, and consulting engineers for the Lochaber project, which has at length been sanctioned by Parliament. Messrs. Meik were also the engineers appointed by the Government of Bombay, as their advisers on the Back Bay reclamation scheme.

Mr. Meik was a member of the committees on water power developments in Scotland and Ireland, and was consulted on important engineering projects in Gwalior, Greece, Portugal and Spain. He took also a special interest in the Severn water power scheme. His firm, Messrs. C. S. Meik and Buchanan, of 16, Victoria-street, S.W., were, moreover, consulting engineers for the port of Rangoon, and his advice was in constant request by harbour and port authorities at home and abroad.

Amongst his other activities, Mr. Meik found time to help in preparing and revising the British Engineering Standard Specifications for Portland cement, and he was a member of the sub-committee appointed by the Institution of Civil Engineers to report on the deterioration of structures by the action of the sea. It may also be noted that nearly twenty years ago he adopted reinforced concrete for piers at Purfleet and Puzzuoli.

His intimate acquaintanceship with harbour and dock engineering led to his being requested to act as one of the "general reporters" to the recent International Navigation Congress. The work involved was most efficientiy carried out, although Mr. Meik was confined to his bed as the result of a serious operation.

THE SMOKE PROBLEM.—Dealing with this subject in the *Fuel Economy Review*, Professor J. O. Arnold, F.R.S., states that a thoroughly good furnaceman, when re-heating steel containing much carbon, would not avoid smoke if he could, and he could not avoid it if he would. Heavy ingots must be heated from a cold condition to a mellow yellow forging heat very gradually, or they will crack or "clink," and so become scrap. Therefore in the early stages of reheating a relatively cool green or smoky flame must be maintained. Hence in the first stages of re-heating dense black smoke is deliberately evolved as part of the manufacturing process and to the end of the operation from time to time there must be smaller emissions of smoke as the furnaceman manipulates his furnace so as to avoid a dry flame containing an excess of oxygen. At the present time Sheffield furnace men are re-heating comparatively small (and though not very high in carbon, very sensitive) alloy steel ingots of a value, of probably 150*l.* each, and an error of judgment on their part leading to an early production of a "dry flame" even for a very few minutes, may turn these costly ingots into scrap; it will be evident, therefore, that irresponsible people who, with the best intentions, endeavour to handicap these men in their important work, by forcing them to reduce their smoke, commit something worse than a crime, namely, a blunder.

THE NATIONAL PHYSICAL LABORATORY.

(*Continued from page* 15.)

Aerodynamics Department. (Messrs. R. V. Southwell, M.A., superintendent, E. F. Relf, A. Fage, J. L. Nayler, L. W. Bryant, T. Lavender, H. B. Irving, W. L. Cowley, W. F. G. Simmons and others.)—Apart from researches conducted for Government Departments, the programme of the Aerodynamics Department includes experiments approved by the Aeronautical Research Committee, details of which are generally published in the Reports and Memoranda of this committee. We notice in the first instance novel apparatus.

One-Foot Model Wind Tunnel. (Mr. Simmons.)—For the investigation of the rate of variation of the static pressure along a wind tunnel, a square tunnel of 1-ft. sides, 11¼ ft. long, has been constructed of wood; it opens out conically at the intake end and pyramidically at the other end. By the aid of a 1-h.p. electric motor and an air-screw, wind speeds of 50 ft. per second can be produced. Tapers ranging from 0 up to 0·234 in. per foot, increasing towards the air-screw end, are obtained by fitting internal liners into the tunnel; the object of the experiments was to find the taper suitable for the suppression of the static pressure variation. With a taper of 0·058 in. per foot this pressure remains reasonably constant over 2½ ft. of the tunnel length, and it is hoped that the pressure gradient may be similarly eliminated in large tunnels.

Bristol Fighter Model. (Mr. Relf.)—A one-fifth scale model Bristol Fighter, of 8 ft. span and 13 in. chord, has been constructed for the Air Ministry and has been suspended on wires in the duplex tunnel, for testing the performance of these machines and to determine, for the first time, the effect of the slip stream upon the behaviour of a machine as in actual flight. For this purpose the model contains its own motor for driving its screw, and is fitted with a dummy radiator and other parts. The motor is a 1½-h.p. three-phase motor, about 12 in. long, driven through mercury cups (outside the model) from a motor generator and a 110-volt battery (to ensure constancy); voltage and frequency are independently variable on the alternating-current side for tests with different air screws.

Continuous Rotation Apparatus.—The design of the apparatus for measuring the rate at which the rolling moment, of a complete model plane or of wings, varies with the angular velocity of roll (when the roll is small) is also due to Mr. Relf. Similar apparatus recently constructed at the Royal Aircraft Establishment were not intended and not suitable for very low rotational speeds, because the friction torque of their supporting bearings is included in the measurement of the rolling moment. In the new apparatus the ball bearing is replaced by a two-point support. The model is driven by a 0·1 h.p. electric motor which is carried under a saddle; the saddle is prolonged in a horizontal supporting beam which is above the motor shaft; the beam is surrounded by a tube (running on the beam in roller bearings) and a trunnion piece on the tube is attached, at adjustable incidence, to the machine to be tested; the motor shaft drives the tube through a worm gear; the current is taken to the motor through helical copper springs which have been found preferable to mercury cups. The carefully-balanced model is rotated, up to 10 times per minute, first in one direction and then in the other; the rolling couples due to the action of the wind are determined with the aid of the roof balance; the difference of the readings at equal rotation speeds in opposite directions gives twice the rolling couple produced by that rate of roll.

Three-Force and Three-Moment Apparatus.—An attachment has been added to the main balance, the principle of which was explained on page 98 of our issue of July 15, 1921, to permit of measuring the three forces and three moments acting upon a model aeroplane in asymmetrical presentation. The model is supported by means of a gimbal ring at the upper end of a spindle which is held in the main chuck of the balance. The measurements can be made by balancing or by locking the two weighing beams, which are at right angles to one another, for various angles of yaw without stopping the wind, the whole of the subsidiary beam system being rotated together with the upper part of the balance supporting the model.

Calibrating Bell Crank.—In calibrating drag balances and other apparatus in a wind tunnel, the practice had been to hang a weight over a pulley mounted on a horizontal spindle. This method was not found convenient for measuring forces up to 60 lb. in the duplex 7-ft. channel, and a bell crank has been constructed which has four fulcrum points at the corners of a crank frame of the shape of a right-angled triangle. Two of the points are at the right angle, where the crank is attached to its tripod; from the third fulcrum the scale pan is suspended, and the fourth takes a cross-piece attached to the horizontal wire effecting connection with the balance to be calibrated. All the four points are adjustable; the whole bell crank can be reversed so that the balance fulcrum may serve for the wire connection; two readings can be taken to allow for slight inequality in the lengths of the lever arms, and the tripod itself stands on fulcrum bolts.

Aerofoils. International Trials.—The trials which we mentioned last year (ENGINEERING, July 14, 1922, page 51) have practically been completed both over here and in France, but the report from America has not yet been received. The work done at Teddington comprises an aerofoil R.A.F. 15 section of twice the size so far tested, having a chord of 12 in. and a span of 72 in., and the tests have been made at angles of incidence between − 4 deg. and + 20 deg., and at wind speeds ranging from 20 ft. up to 100 ft. per second. Biplane sections of half the dimensions mentioned with square wing tips and the effects of various stagger and gap/chord ratios are also being examined. Two similar foils have been tested arranged in tandem, at various distances apart and various angles of *décalage*.

Stability and Control.—The new appliances above-mentioned have proved very useful in the further investigation of the lateral stability. It is found that all the rotary derivatives are difficult to measure accurately at angles of incidence between 16 deg. and 24 deg., the values becoming steadier at larger angles. The measurement of L_p, the damping of the rolling oscillation, gave a surprising result. Theoretically one would expect this derivative to change sign at angles above the stall, *i.e.*, the angle at which the lift is maximum and the flying speed minimum. The L_p measurements, on the contrary, indicated that the derivative had become greater than at normal flying angles, and experiments with the continuous rotation apparatus confirmed this; the rolling would at times be of the same sign as the rolling angular velocity (of small value) showing that a rolling disturbance would tend to increase; at other times the signs would be different, indicating a damped motion in roll; the whole motion then seemed very critical. When a monoplane wing was mounted in the rotation apparatus, the rolling disturbance tended to increase. The observations agree with the impressions of pilots concerning the commencement of a spin. Machines indicating a positive L_p are easily put into a spin; others have to be "pushed" into a spin; in the latter case the L_p is negative at small rolling speeds, but becomes positive as the rate of roll increases, the case being observed with biplane models. It would appear that, if the tendency to start auto-rotation can be eliminated, *i.e.*, if L_p can be kept negative up to a reasonable value of the rolling angular velocity, the problem of stalled flight can be solved by providing sufficiently large control surfaces for dealing quickly with the disturbancies encountered in flight. One disadvantage of the present system of aeroplane control is that, on a turn, appropriate setting of the ailerons introduces a yawing moment tending to neutralise the effectiveness of the rudder, especially at large angles of incidence, when the yawing moment due to the ailerons becomes large. Experiments are being made on modifications of the lateral control in roll.

Pressure Head Instrument.—Attempts to design an instrument without moving parts which would indicate the true static pressure irrespective of the direction and strength of the wind have unfortunately proved unsuccessful, and Pitot tubes on swivelling vanes can so far not be dispensed with. Twenty Venturi tubes were symmetrically disposed over the faces of a hollow icosahedron made of brass, and this and other apparatus were tested at different angles of yaw and different speeds in a wind channel; but the internal pressure (in the spherical chamber of the icosahedron) fell in all cases below the true static pressure.

Air Screws. (Mr. Fage.)—The suspension device used in the testing of families of air screws was illustrated last year. In the now completed research the variables of the family were pitch-diameter ratio, number of blades, and blade width, the other shape characteristics, plan form, blade section, &c., being fixed according to the best British practice. The experiments were made with bosses designed to take either two or four blades, or three or six blades; 11 types of blades varying widely in aspect ratio (ratio of radius to width); 44 blades have been tried and 26 air-screws have been built up of these. The results accord on the whole with expectation and they give definite figures of both practical and theoretical value. Within the present range of shape characteristics, it is concluded, the air-screw efficiency increases with the aspect ratio (the longer the blade, the more efficient) and with the pitch-diameter ratio, but decreases as the number of blades is increased. The series of air-screws obtained by rotating the blades of a normal air-screw which was designed to have a constant geometrical pitch-diameter ratio of 0·7, is almost identical, as regards performance, with the normal series of air-screws designed with pitch-diameter ratios ranging from 0·3 to 1·5. The principal effect of either a tractor or a pusher body is to increase the thrust, torque and efficiency—the efficiency increase is fictitious, of course, because it is obtained at the expense of the body drag; the effect of the air-screw is to increase the body drag, the increase being proportional to the screw thrust, for a constant forward speed. These data are sufficient to allow of generalisation in air-screw design.

Airships.—Full-scale work on airships has been stopped during the year, but work on models has continued.

Theoretical Researches. Control. Tapered Aerofoils. Stresses. Vibrations of Air-Screw Blades. (Messrs. Southwell and Fage.)—The behaviour of an aeroplane of the D.H.9A class under the influence of certain typical control movements and of typical accidental longitudinal and lateral disturbances has been deduced from model data taken from various sources. So far as rotary motions were concerned, the moment of inertia of the machine was found to be of surprisingly little importance in determining the motion caused by the couples due to controls and gusts. A wind with a gradient in its vertical velocity component would cause the machine to respond almost instantly and to attain the equivalent rolling velocity within one-fifth second; the response to a yawing couple was much slower, and that factor would appear to be decisive for the difference in behaviour between heavy and light machines. The deductions are of considerable interest especially also as regards landing in confined spaces.

The analyses made of experimental data from both rectangular and tapered aerofoils establishes for monoplanes the soundness of the Prandtl vortex theory, according to which the air streams caused by the excess pressure on the underside and the partial vacuum above the aerofoil produce eddies at the trailing edge which derive their energy from the aerofoil. For practical purposes the change of air flow towards an aerofoil tip is found to be of the same nature as that due to a change of incidence, and this change of incidence can be calculated with great accuracy from the circulation over the entire aerofoil. Formulæ for solving Prandtl's complex equations have recently been given by Betz and Trefftz; Mr. Fage has deduced an easy graphical method.

As regards stresses induced in the fuselage by torsion, flexure and shear, Mr. Southwell has extended his theoretical investigation, and methods have been devised for estimating the stresses induced in a braced tube of any uniform cross-section or in a tapered structure similar to a bag of a rigid airship. With respect to the gravest frequency of the flexual vibrations of an air-screw blade, a close low-limit

estimate can be obtained from the formula $p^2 = p_1^2 + w^2$, and an upper limit $p^2 = p_1^2 + a\,w^2$, where p_1 is the gravest frequency in the absence of rotation, w the angular velocity and a a constant.

Theoretical Stream Lines of an Inviscid Fluid. (Mr. Relf.)—The demonstration of an electric method for the rapid determination of the stream lines of an inviscid fluid past an aerofoil of any section was very instructive. When an insulated conductor such as an aerofoil model of aluminium is placed in the homogeneous electric field between two parallel plates, the equipotential lines are identical in form with the stream lines in a perfect fluid (devoid of viscosity) flowing parallel to the plates past the same obstacle. The aerofoil model is placed vertically on an insulating base, in the centre of a rectangular tank, 5 ft. by 2½ ft., 1 ft. deep, filled with water; the long sides of the tank are electrode plates of aluminium, joined to an alternator generating current of a few millivolts at 500 cycles per second. There are further two exploding electrodes connected to telephones through a three-valve amplifier; one electrode is fixed to one of the short sides of the tank, the other is attached to a pantograph framework and moved successively to different points in the tank. All the points at which no sound is heard in the telephone are on the equipotential through the fixed electrode, *i.e.*, on a stream line for the case of fluid flow. By setting the fixed electrode in a number of different places, any number of stream lines can be drawn, which the pantograph plots on a sheet of paper. Thus the stream lines can be plotted out in a few hours, whilst calculations would take weeks; the determinations of the equipotential points can be made within 0·01 in. The water must not be made a conductor by the addition of salt, as the differential effect due to the conductivity of the metal and the fluid is relied upon. Further, when the model is given a definite potential by connecting it to some point on a potentiometer across the alternator terminals, the stream lines can similarly be drawn for a case of fluid flow combined with circulation; in this way Prandtl's theory is being tested.

The William Froude National Tank. (Mr. G. S. Baker, superintendent; Mr. J. L. Kent, Miss E. M. Keary, Messrs. G. H. Bottomley, C. Wigley, W. G. A. Perring, A. W. Riddle.)—The staff remains as in 1920, but the continued depression in the shipbuilding and marine engineering world is reflected in the diminished demand for industrial test work. That has left more time for research; the Tank is at work for five days of the week from 7·45 a.m. to 9 p.m. Half of the annual cost of the research work (now 5,000*l.*) is raised by the Advisory Committee, and a considerable number of firms contributed to the Tank funds; but further guarantee by the industry is desirable, and also recognition of the fact that the highly-trained staff at Teddington is able and willing at any time to assist with any particular problem as to the form and propulsion of ships.

The standard data obtainable concern the resistance of any shape form and speed and possibility of improving the form; the effect of rough water on resistance, pitching, &c.; the propulsive efficiency of twin and single-screw ships; the measurements of wave profiles along the side of the ship at any speed; the forces upon rudders, &c.—for ships as well as for motor boats, hydroplanes and flying boat aeroplanes. The offer of assistance applies to ships' trials, including steam trials, generally; the Tank department would rather send one of their staff, who will also report on weather, sea and amount of structure exposed, than work from data submitted.

Tests for Forms.—The falling-off in the normal testing of ship forms has continued throughout 1922, the numbers of models tested in the last three years being 69, 38, 35; there has, however, been an improvement since last winter. The greatest reduction in power obtained is 6 per cent. at service speed, without alteration of either dimensions or displacement. In the propulsion tests with screw propellers behind the model, screw propellers are made exactly to the firm's design as regards rake, set back and other special features, and this practice will be maintained until the importance of these features can be determined. Sometimes experiments are made at two draughts, deep and light. The steering qualities of one ship have also been investigated in shallow water, and the shallow water test will systematically be adopted. For this purpose a false bottom, 120 ft. long, made of wood, is put right across the tank.

Aeronautical Work.—One of the particular problems investigated is whether a flying boat of straight frames, sides and bottom, can be designed to be stable as regards pitching and free from porpoising (*i.e.*, leaping out of the water) at all speeds, the loading-up qualities of this type of hull being compared with that of the hooped section type previously tested. The experiments with two twin-float, amphibian-type models showed that it is possible to fit floats of this nature with non-retractable wheels without impairing the longitudinal stability; with suitable arrangements nose-diving will not occur, and a tail-float need not be provided. The full-scale research work on measuring the blow on the bottom of an elastic flying boat hull, 30 ft. long, of the P. 5 type (the floor is superposed on a large number of small members so that the hull can give to the water forces), when taxiing (*i.e.*, running on the water at speeds below flight speeds) has not been proceeded with owing to lack of facilities at the flying station.

Waves. Resistance to Propulsion and Pitching.—The model experiments on mercantile cargo vessels, which brought Mr. Kent the gold medal of the Institution of Naval Architects last year, have been followed by observations taken by Mr. Kent on board two Atlantic liners of the Canadian Pacific Steam Navigation Company and of Messrs. Furness, Withy and Co., and on an oil tanker of the Eagle Oil Company.

Manœuvring of Ships.—This Research of Mr. Baker and Mr. Bottomley was noticed last year (ENGINEERING, July 21, 1922, page 85). Progress has since proceeded mainly along two lines. Apart from the effect of waves, it was supposed, and has been confirmed by Miss Keary, who is in charge of this research and has designed the apparatus, that the largest forces upon the rudder would be produced when the ship had started yawing in one direction under helm and the rudder was then reversed to full helm on the other side in order to check the yaw. For the measurements of the moments on the rudder stock the same model is used as before, but the model is so arranged that it can yaw to port and starboard through angles of 10 deg. and even 15 deg., as was demonstrated by Miss Keary on the annual inspection day. The model is placed under the travelling bridge and moves first with it, the special motor of the model propeller being controlled by the main motor; when speed synchronism is obtained the model is released and proceeds under its own power, while the rudder is put over and is reversed automatically when a contact is made, the rudder arm moving over an arc containing mercury cups. The motor working the rudder winds up or slackens the cord of a transmission dynamometer on the stern. The actual deflections of the boat resulting from the movements of the rudder are determined with the aid of two contact devices placed fore and aft in the body of the boat. Independent records of time, angle of helm, maximum yaw and turning moment on the rudder stock are automatically taken on two drums. Considerable mechanical difficulties had to be overcome as many devices, including the recording gear, have to be accommodated on the stern of the model.

The second extension of the work by Mr. Bottomley concerns the relative steering qualities of a ship and the forces on a single rudder with twin screws and single screws. When the single screw is removed, the propeller aperture is filled up with a solid plate and twin bossings are fitted in. The rudder remaining the same, the forces on the rudder are found to be much smaller with twin screws than with a single screw, and this diminution of force is reflected in the smaller ship turning moment on the model; that means that, for the same rate of turning, a larger area of rudder is required with the twin screws than with the single screw. The effect of the working of the propellers on the rudder forces was very slight for all angles of helm and was better with inward turning screws than with outward turning screws. A report on these researches is being brought before the Institution of Engineers and Shipbuilders in Scotland.

Screw Propellers.—An account of this research by Mr. Baker and Mr. Wigley was discussed by the Institution of Naval Architects last spring (ENGINEERING, April 20, page 507). In the further work the influence of the fullness of stern, of propeller dimensions and its closeness to the ship, of the lateral proximity of the screws and the interaction between ship and propeller generally will be investigated in co-ordination with the analysis of steam trial data presently to be mentioned. How the propellers for the models are made with the aid of a strickler gauge, clay, and plaster of Paris, and are cast and checked, all in about a week, was demonstrated by Mr. E. H. Dawes.

Resistance in Air and Water.—The design of apparatus to be used for comparative resistance measurements in air and water has been settled, the bodies to be either blunt or with fine lines, the same gear supports to be used in the two fluids. The air experiments have been started by Mr. Southwell in the Aerodynamics Department; the Tank work has not yet been taken in hand.

Stream Line Flow Research.—Mr. Perring has devised apparatus for measuring the stream line flow past a model immersed to a depth of 5 ft., to be free from surface effect. From a horizontal chamber eight vertical glass tubes extend downward and are joined to a multiple valve; from this valve branch off 24 brass tubes, to be switched in as desired, which are placed in the boat, with their open ends penetrating through the shell of the boat and ending flush on the outside, so that the flow past the different portions of the boat can be investigated.

Steam Trial Analysis.—When the values of the model tests on propulsive coefficient, wake, hull efficiency, are applied to the ship and its performance, certain discrepancies are revealed, to clear up which Mr. Baker is collecting and analysing the material available, on trials on a measured-mile course, trials over a long course and on log data from actual service. Unfortunately many of these data are of little value; but the importance of securing reliable information was fully recognised when Mr. Baker raised the question in a paper on "Measured-Mile Trials and other Ship Propulsion Data," before the North-East Coast Institution of Engineers and Shipbuilders last winter. Agreement must be found between the screw thrust and ship resistance on the one hand, and the shaft horse-power and the measured power of the ship on the other. But even the usual trial runs, one run each way over the mile at each speed, are rarely satisfactory; an interval of half an hour between two runs may affect the speed on some courses, and the resistance varies as the cube of the speed. Trials at light load of a ship which will have its propeller well immersed are not of practical value, and with single-screw ships in particular the model wakes are high compared to the ship wakes, so that comparison depends upon uncertain assumptions. Normal ship logs, taken by the engineer without particular trouble, are misleading; the logged powers far exceed the calculated powers, owing to loss of screw or engine efficiency, or to the taking of diagrams when the engines have temporarily been worked up. With the assistance of builders and owners, however, much valuable information could be obtained.

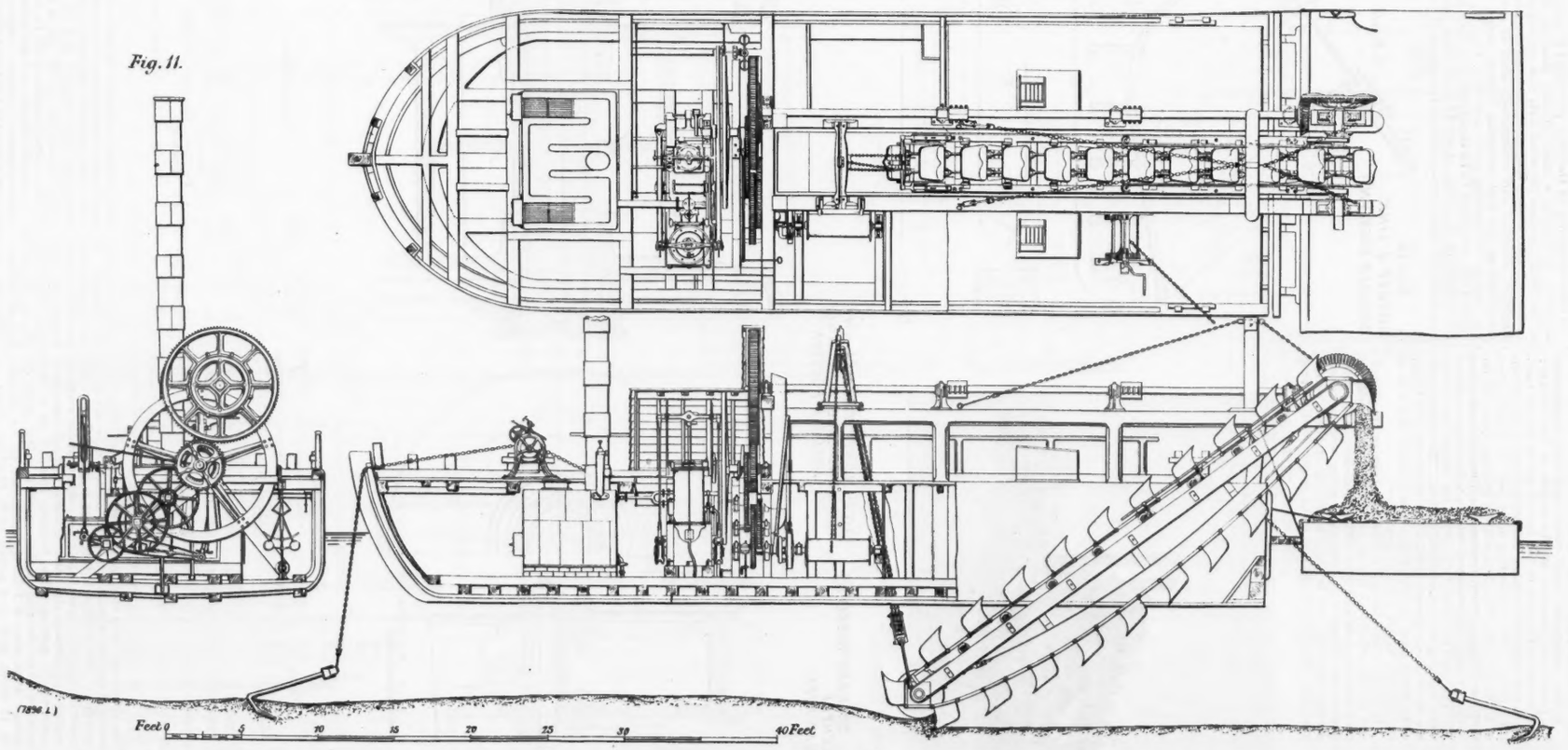
(To be continued.)

THE INSTITUTION OF GAS ENGINEERS.—Mr. Samuel Tagg, engineer and manager of the Preston Gas Undertaking, was elected president of the Institution of Gas Engineers at its recent annual meeting held at Belfast.

CAST-IRON CONCRETE-LINED WATER MAINS.—Messrs. Cochrane and Co., Limited, Ormesby Ironworks, Middlesbrough, have just secured an order from the Aberdeen Corporation for the supply and delivery of 3 miles of 48 in. diameter cast-iron pipes lined centrifugally throughout with 1 in. thickness of concrete. Messrs. Cochrane recently acquired the sole rights in the United Kingdom and Ireland, and other foreign countries for the manufacture of concrete pipes by the mechanical centrifugal process known as the "Vianini" system, which is also adaptable for the lining with concrete of cast-iron, steel and other classes of piping. Messrs. Cochrane have very materially reduced the cost to the Aberdeen Corporation by undertaking to do the necessary concrete lining of their cast-iron pipes on the site of the pipe tract in the vicinity of Aberdeen, thus taking advantage of the large savings in railway carriage on the very many tons of concrete which will be required.

THE FIRST STEAM DREDGER ON THE RIVER CLYDE.

Fig. 11.



Hull built of wood; length, 59 ft. 9 in.; breadth, 19 ft. 10 in.; depth, 8 ft. 3 in.; draught, 4 ft. 6 in.; number of buckets on trussed wooden ladder, 22; capacity of each bucket, 4¼ cub. ft.; height of centre of top tumbler, above water-line, 9 ft. 9 in.; length of ladder, between centre of top and bottom tumbler, 34 ft.; dredging depth with ladder at an angle of 36 deg., 12 ft.

MODERN DOCK APPLIANCES.

*Modern Dock Appliances at Glasgow Harbour, including the Handling of Grain in Bulk, also Dredging Plant.**

By DANIEL FIFE, Mechanical Engineer, Clyde Navigation Trust, Glasgow.

(*Concluded from page* 34.)

DREDGING PLANT.

A PAPER dealing with the equipment of Glasgow Harbour would be incomplete without some reference to the deepening and maintenance of the channel and docks. The early appliances used for deepening the channel consisted of plough and rakes, which were operated by hand winches, also harrows attached to the stern of small steamers. These were used to tear up the bottom of the channel and the current carried this material away.

An improvement on these methods was adopted at the beginning of last century by hand dredgers, and in 1824 the first steam dredger on the River Clyde was put to work; the general arrangement is shown in Fig. 11, above. Of this design three were built for the Clyde, two for Dublin, one for Drogheda, one for Leith, and one for Montreal by Messrs. Claud Girdwood and Co., Glasgow. The hulls were built of wood, and the leading particulars of the vessels are as follows: Length, 59 ft. 9 in., breadth 19 ft. 10 in., depth 8 ft. 3 in., draught 4 ft. 6 in.; there were 22 buckets each of a capacity of 4¼ cub. ft., and capable of dredging at a depth of 12 ft. below water-level with the ladder at an angle of 36 deg. The dredgings were discharged over the stern of the vessel on to wooden flats which were towed by a small tug-boat and discharged on to the flat ground along the banks of the river or used in filling up between the training walls.

The dredging machinery was operated by a side lever engine with flywheel and gearing. The bucket ladder hoist was also operated from the main engine through a clutch and brake. The boiler was of the tank type, and from the drawing it will be observed that an attempt was made to obtain efficiency by giving the flue gases a tortuous passage between the fire grate and the funnel.

Gradual progress was made in the design of the dredging plant, and six machines of the double-ladder type were constructed between the years 1851 and 1860, when No. 7 dredger was built by Messrs. A. and J. Inglis, the general design of which was very similar to the earlier dredgers, the chief departures being that the hull, framing and bucket ladder were made of iron, and the winches were operated from the main engine.

In 1865, No. 8 dredger was constructed by Messrs. A. and J. Inglis. The design of this vessel was a departure from the previous types, inasmuch as the framing supporting the ladder was brought in from the end of the vessel, nearer amidships, and the shoot for discharging the spoil was arranged so that the hopper barges could be loaded alongside.

All the foregoing dredgers have been out of service since 1906, and the present plant consists of the barge loading dredgers mentioned in Table VII (page 60).

The dredger Rosslyn is illustrated by Fig. 12, and was designed by the author to undertake the dredging of hard clay and boulders, which extend for several miles of the channel. There are a number of details on this vessel which have been found in working to be highly satisfactory as regards maintenance and operation. One special feature is the type of framing for supporting the top end of the ladder. The usual design of this detail consists of box-girders carried up from the floor of the vessel, connected at deck-level, and tied at top by box beams, whereas the design under review consists of the bucket-well plating being carried to the top of the framing and stiffened by steel channels, beams and rider plates. This method allows of an efficient attachment to the strongest part of the hull, and all parts of the framing are open to inspection and can be coated to preserve them against corrosion. The shoots are specially constructed to withstand discharge of boulders, the plating at this part being 1¼ in. thick, and the shoot door is formed by a solid slab of high-tensile steel, 7 in. thick, which after ten years' service, is still in use.

The vessel is single-screw self-propelling, the engine being of the three-crank compound type working at a pressure of 125 lb. per square inch. This type has been found much more satisfactory for dredging purposes than two-crank compound or three-crank triple-expansion engines. Gearing is provided in the engine-room to allow of the speed of buckets being altered from 10 to 18 per minute. Intermediate speeds are regulated by adjustment of the governor on the engine. The gearing is of high tensile cast steel, having double helical machine-cut teeth and engaged and disengaged by screw gearing. The

* Paper read before the Institution of Mechanical Engineers at Glasgow, June 27, 1923.

gears only come into operation when on slow speed, the clutch shown being disengaged during this time. On faster speeds the clutch is engaged and couples the shafting direct, and thus obviates the sliding wheels, also the excessive noise and vibration which are associated with the usual gear in the engine-room of a dredger.

The usual bevel gears of cast steel, having machine-cut teeth, are provided at top and bottom of the vertical driving shaft, and adjustable bearings are provided for taking up the end-thrust. The main driving wheels, 15 ft. diameter of pitch circle, are fitted on taper seats and secured on the end of the tumbler shaft by two feathers as shown in Fig. 13, which allows of the wheels being easily removed when the tumbler requires to be replaced. To provide for some relief when the gearing is subjected to an excessive stress, the rim of the wheel is not attached to the centre otherwise than by the side ring, which is held in place by a number of bolts. The surfaces in contact are lubricated and the rims can be made to revolve at a predetermined load by the adjustment of the bolts. The upper tumbler is five-sided, which has been found to be more economical in respect of tear and wear of the bucket chain, and no difficulty has been experienced through slipping when dredging hard material.

The lower tumbler is six-sided and revolves on a fixed shaft 14 in. in diameter, secured by cast-steel brackets on the end of the ladder. Messrs. Lobnitz's sand-excluding and lubricating device is fitted as shown in Fig. 14. This consists of cast-iron end rings bearing on renewable cast-iron plates on the end of the tumbler and kept up to the face by springs, the tumbler being free to move endwise. The lubricant used is grease, forced from a pressure-cylinder on the deck of the vessel, and coupled by a pipe to the end of the shaft which is provided with a device for retaining the pressure of grease. Shafts and bushes of tumblers lubricated in this manner have given about six times the wear of shafts unlubricated; a large saving is also effected in the power taken to drive the bucket chain. The lower end of the ladder is carried out beyond the flange of the tumbler, fitted with cast-iron blocks of circular form which effectively prevent the buckets from being thrown off the tumbler when working among boulders. Two sets of buckets are supplied: One set of 17 cub. ft. capacity for hard material and one set of 25 cub. ft. capacity for dredging sand and mud. The small buckets are of very heavy scantlings as shown on Fig. 15, the backs being of cast steel; the thickness of the metal in the hood is 1¼ in. and the wearing part on bottom 2 in. thick. The body plates are double-riveted to the hood.

Rolled manganese steel plates and cast manganese lip plates are provided on the mouth of the bucket; the bushes in the eyes of the bucket are of special cast-steel, machined all over and tempered before being driven into place. The connecting links are of forged steel of 40 tons tensile, 3 ft. 2 in. centres between eyes, 10½ in. deep, and 7½ in. broad, recessed on the sides and fitted with soft centre carbon-steel bushes which are tempered and the ends softened to prevent the bushes fracturing when working with pins slightly worn. The bucket pins are made of manganese steel, 4⅜ in. diameter, and these, after being used in this dredger, are forged down to a smaller size to suit other dredgers.

Winches of exceptionally substantial design are placed, one at the stern and two at the bow of the vessel, all motions being controlled by friction clutches. The centre chains are operated by cast-steel gipsy wheels, which greatly facilitate the laying and lifting of the mooring anchors. Sufficient length of chain is provided so that the vessel can drop stern anchor, steam ahead, drop bow anchor, and haul back on stern anchor into dredging position. The bucket ladder hoist is placed below the main deck and is operated by a double-cylinder vertical engine which drives the hoisting barrel through cast-steel machine-cut gearing. The hoisting speed is 16 ft. per minute. The hoisting tackle consists of 10 parts of plough steel wire, 6·3 in. circumference of six strands of 37 wires each and tested to a breaking stress of 130 tons.

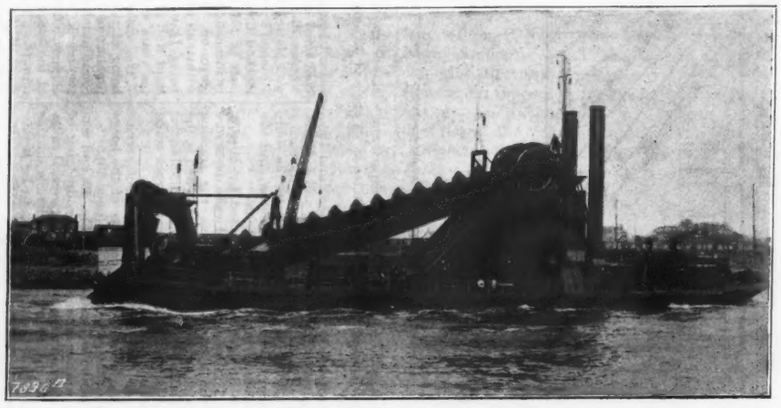


FIG. 12. DREDGER "ROSSLYN."

Fig. 13. TOP DRIVING WHEEL WITH SLIPPING CENTRE. DREDGER "ROSSLYN." HARD CAST-IRON RIM WITH CAST-IRON CENTRE. NUMBER OF TEETH 113, PITCH 5 INS., P. C. D. 15 FEET. WIDTH OF TEETH 10¾ INS.

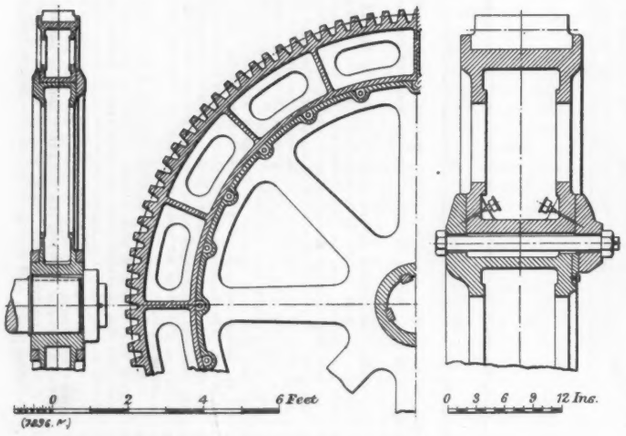


Fig. 14. LOWER TUMBLER WITH SAND-EXCLUDING RINGS. DREDGER "ROSSLYN."

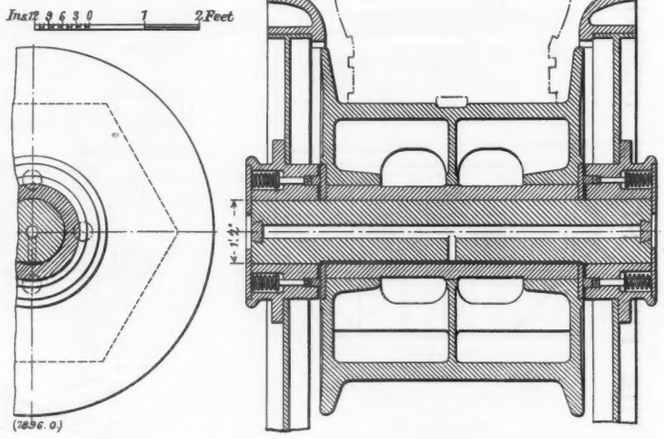


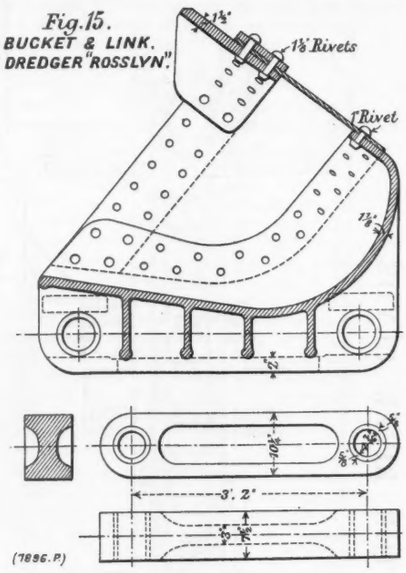
TABLE VII.

Name.	Dimensions. Length.	Breadth.	Depth.	Capacity of Buckets.	Dredging Depth.	Year Built.	Name of Maker.
	ft. in.	ft. in.	ft. in.	cu. ft.	ft. in.		
Cairndhu	194 2	37 2	12 0	22	40 0	1892	Fleming and Ferguson, Paisley.
Craigiehall	187 3	38 0	13 0	20	48 0	1904	Wm. Simons and Co., Limited, Renfrew.
Shieldhill	187 3	39 0	13 0	20 / 15	48 0	1906	Ferguson Brothers, Limited, Port Glasgow.
Rosslyn	189 0	39 6	13 0	17 / 25	48 0	1912	Lobnitz and Co., Limited, Renfrew.

HOPPER BARGES.

As the deepening of the river proceeded it was found necessary to employ a more efficient plant to dispose of the dredgings than the wood flats then employed, and in the year 1862 Messrs. William Simons and Co., Limited, Renfrew, designed and constructed what is generally recognised as the first sea-going hopper barge, which was capable of carrying about 300 tons, Fig. 16. This enabled the dredgings to be deposited at a deep part of the estuary of the river, about 27 miles from Glasgow, at a greatly reduced cost. Several features in the design of this vessel are still retained in hopper barges recently constructed. Hydraulic gear was employed for operating the hopper doors. Of recent years the depositing ground has been altered to 40 miles from Glasgow, and the later barges are each capable of carrying 1,200 tons of sand. These vessels are 205 ft. overall length by 35 ft. mould breadth by 15 ft. 6 in. mould depth, and are propelled by twin-screw triple-expansion steam engines of 1,200 i.h.p. collectively at a speed of 10½ knots when fully loaded.

Fig. 15. BUCKET & LINK. DREDGER "ROSSLYN."



MODERN DOCK APPLIANCES AT GLASGOW.

Fig. 16. HOPPER BARGE No. 1. BUILT IN 1862. (MESSRS. W. SIMONS AND CO., RENFREW.)

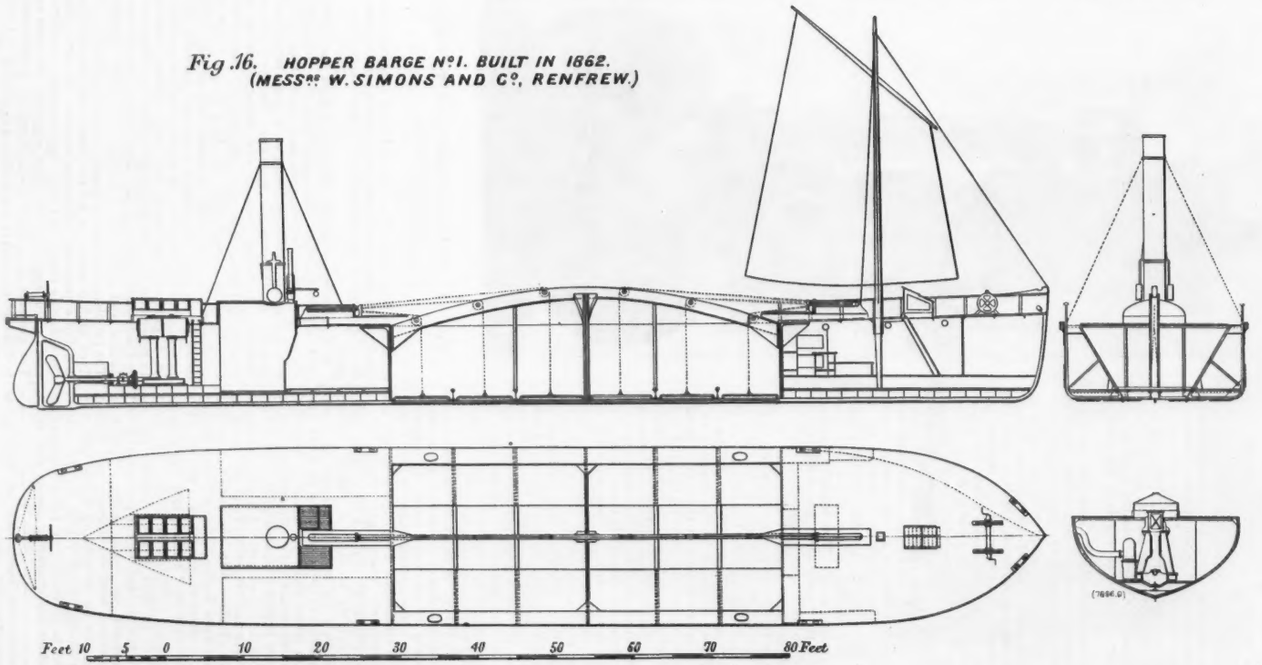


Fig. 17. SAND-EXCLUDING & OIL-RETAINING APPLIANCE FOR PROPELLER SHAFTS. HOPPER BARGES.

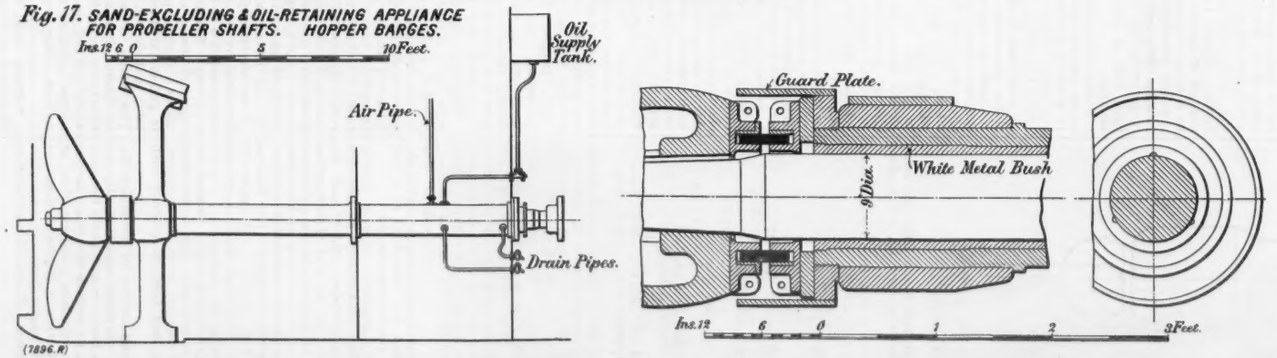
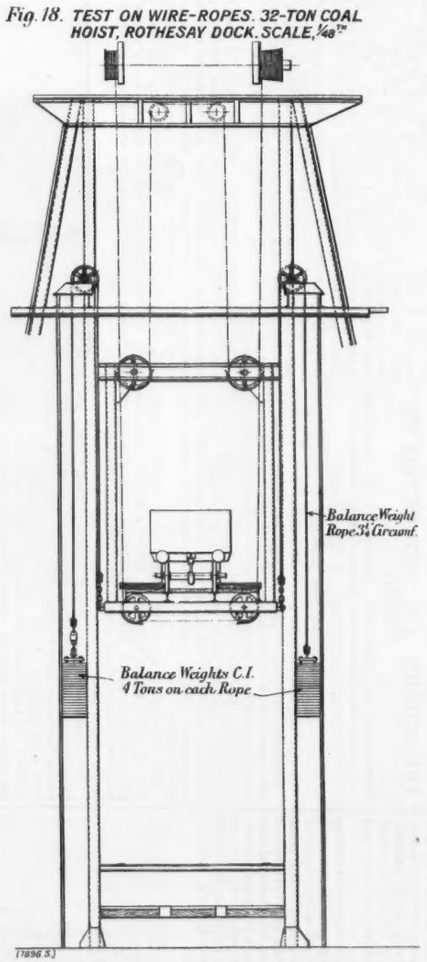


Fig. 18. TEST ON WIRE-ROPES. 32-TON COAL HOIST, ROTHESAY DOCK. SCALE, 1/48TH.



One feature of the latest type of barge, four of which were built by Messrs. Lobnitz and Co., Limited, in 1911, is the method employed to preserve and lubricate the propeller shafts, which appliance, Fig. 17, has greatly reduced the maintenance charges, and enabled the vessels to be more fully employed. The tailshafts, 8 in. diameter of body, are without liners, but swelled at ends in way of bearings to 9 in. in diameter, and the bushes of the stern tubes are 4 ft. long at outer, and 2 ft. long at inner, end.

The protecting device consists of a rubber ring, 1½ in. thick, which is secured to and revolves with the propeller, in a groove formed in a cast-iron ring, bolted to the end of the stern tube. The pressure of oil from a tank placed in the engine-room casing forces the rubber ring against the brass bush in the casting and effectively prevents the escape of oil and the ingress of sand. Air and draw-off pipes are provided for the circulation of the oil, and a steel shield is fitted to protect the rubber ring. The whole of the shaft from the propeller nut to the gland in the engine-room is under oil pressure and so effectively protected and lubricated that, in a propeller shaft recently drawn after ten years' service, when the vessel had run a distance of 160,000 miles, no signs of deterioration or wear could be observed. The tool marks of the machining are still plainly to be seen on the bearing parts of the shaft and bushes.

As a comparison with similar size of shafts employed on the same duty, having phosphor-bronze liners, 5 ft. 6 in. long, at outer end and ⅜ in. thick, with lignum vitæ bushes, 4 ft. long, these have a wearing period of about two years, when the liner requires to be turned down to half its original thickness and the wood in the bush renewed. Of the four twin-screw barges built in 1911, only two shafts have been withdrawn, and these were for inspection purposes. The rubber rings are of special composition to resist the softening action of the lubricating oil, and are renewed, on an average, after being in use for four years.

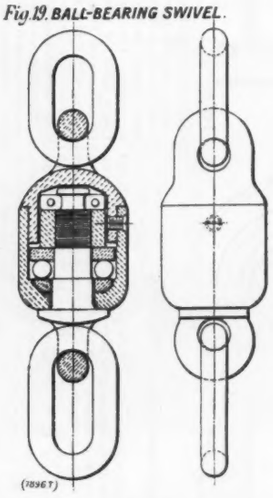
A compound oil is used as lubricant which has the property of producing a creamy lather when mixed with water, and the free acid in a sample, after analysis, was found to be 1·3 per cent., although the shaft had not been drawn or the stern tube drained for a period of 6½ years. The amount of oil used to keep the stern tubes filled is very moderate, taking on an average 10 gallons per month for each vessel at a cost of 2*s.* per gallon, which is a very small charge in comparison with the cost of renewing liners and bushes of hopper barges with unprotected shafts.

Wire Ropes.—Steel wire ropes are now being extensively used in modern dock appliances, and the maintenance of them requires special consideration. The frequent bending over pulleys and barrels, side drag when working cargo from holds, and exposure to atmospheric conditions all tend to the deterioration of the ropes. The latter conditions can be met by the frequent coating of the

rope with a preservative, which should be non-acid and have a mineral oil basis. The diameters of rope barrels and pulleys, also the form of the groove of the pulleys, are all-important factors in the length of service which can be obtained from the ropes, especially at high and moderate speeds.

In a number of applications of wire rope to hoisting appliances, the life of the rope can be greatly increased by the provision of some means to allow the rope to twist and untwist when passing over a pulley. The value of this provision has been demonstrated by a test carried out, extending over a period of one year, on cradle balance ropes on one of the 32-ton coal hoists at Rothesay Dock. Fig. 18 shows the arrangement of hoist, cradle and balance ropes. The cradle, when in operation, is hoisted and lowered at a speed of 120 ft. per minute, and the suspended weights are each of 4 tons.

Fig. 19. BALL-BEARING SWIVEL.



The wire ropes used on test were taken from the same coil of rope, which was manufactured by a first-class maker.

Table VIII gives particulars of construction and tests made on the wires and completed rope :—

TABLE VIII.

Circumference	3·25 in.
Number of strands	6
Number of wires on each strand ...	37
Diameter of wire	0·05 in.
Average tensile strength of single wires	473 lb.
Equivalent strength in tons per square inch...	111 tons.
Average number of twists in 8 in.	56
Average number of bends over radius = D × 3	18·6.
Breaking strain of total wire (222)...	46·87 tons.
Breaking strain of completed rope...	38·7 tons.

The ball swivel, Fig. 19, shown is the standard pattern used on hoisting ropes of the 4-ton mineral cranes at Rothesay Dock, and has been evolved from experience gained in working with various types of swivels. The casing of the swivel is of forged steel throughout, and encloses the ball bearings in such a manner that dust and water are excluded. The locking arrangement consists of a split washer, secured by screws, which effectively prevents the lower portion of the swivel from unscrewing and obviates the use of a split or tapered pin.

The rope on the right-hand side, Fig. 18, was shackled, one end to the cradle and the other to balance weight. The rope on the left hand side was shackled at one end to the cradle, and at the other end was connected to a ball bearing swivel attached to the balance weight.

The ropes were in use for a period of one year, during which time the hoist handled 326,000 tons of coal, the number of lifts being approximately 40,000 and the average height of lift 35 ft. At the end of the period stated the ropes were taken off for examination, when the portion of rope on the right which had been working over the top pulley was found to have a considerable number of wires broken and worn where the strands had been in contact with the pulley. The rope does not appear to have revolved, as the parts of strands which have not come in contact with the pulley are unworn.

The rope on the left fitted with swivel showed on examination no broken wires, and the wires were slightly worn in an even manner over the complete circumference where they had been in contact with the pulleys.

The paper might be carried further by describing the turbine hydraulic pumps operated automatically by high-tension motors, which have been recently installed at Princes Dock, Glasgow, to replace the steam-driven plant, and the substitution of steam pumping plant at Govan Graving Docks by electrically-driven vertical and horizontal pumps; but this might form subject-matter for a paper at a later date when full data of comparative tests will be available.

THE STORAGE AND DISTRIBUTION OF WATER.*

Improvements in Mechanical Contrivances in connection with the Storage and Distribution of Water.

By E. BRUCE BALL, of Kilmarnock.

(*Concluded from page* 32.)

CONTROL OF FLOW IN PIPES.

DURING recent years little change has taken place in the construction of ordinary sluice or gate valves, and developments have been practically confined to methods of operating the valve. Electric or hydraulic operation is now fairly general with positive or automatic control, either at the valve itself, or from a distance, and, not infrequently, sluice valves are operated by compressed air cylinders.

An electrically operated sluice valve would usually have a small reversible motor suitably geared, and the gate spindle would carry adjustable self-replacement limit switches to check the motor at the extreme positions of the sluice gate.

An hydraulically controlled valve would have an hydraulic cylinder operating direct on the gate spindle, and a four-way distributing cock controlling the admission and exhaust of the operating pressure. In connection with air-controlled sluice valves, reference might be made to a pair of 42-in. valves recently supplied in connection with an electrically-driven pumping plant for a large graving dock. A compressed air cylinder using air of 100 lb. to 120 lb. pressure per square inch commands the sluice gate. When pumping is in progress the valve is held open by air pressure under the operating piston. Should the pumping cease due to the failure of current or due to the pumps being shut down, the circuit to a solenoid control is simultaneously cut off and the pressure distributing valve is immediately switched over to admit pressure to the top of the piston, and the valve is automatically closed. Oil dashpots are provided on each side of the air cylinder to regulate the rate of closing.

Sluice valves are also conveniently arranged for automatic control, and may be brought into action either by (1) a rise in pressure in the main ; (2) a fall of pressure in the main ; (3) an increase or decrease in the pipe velocity. Instead of either hydraulic or electrical operation it may be preferred, in the case of automatic valves, that the sluice movement should be produced by deadweight released, or tripped, by the automatic gear. So many different conditions occur in any extensive experience, that it is quite impossible to present typical examples which will cover the whole field ; reference, therefore, will be made to one specimen pattern only, illustrated in Fig. 11. This is one of eight 39-in. automatic self-closing sluice valves, installed at an important hydro-electric power station. The sluice is operated by an hydraulic cylinder controlled by a weight loaded trigger released automatically in the event of an abnormal velocity occurring in the main. The working pressure in the main is 410 lb. per square inch, and the hydraulic cylinder is designed to utilise the pressure in the pipe. The mechanism is clearly seen in the photograph. When the valve is open the underside of the operating piston is in communication with the pressure in the main, so holding the sluice open. A paddle is arranged in the centre of the main pipe and loaded by the weight arm shown, so that it is not displaced by the reaction force due to the normal velocity of flow in the pipe. Should an increase of velocity occur the force on the disc overcomes the weighted lever, and the paddle travels forward with the stream, so releasing a trigger which holds another weighted lever shown in an almost vertical position in the photograph. On release, the small hammer lever falls and strikes the cock lever below it, thus reversing the flow of power water to the hydraulic cylinder and closing the valve. To reset the mechanism it is only necessary to raise the hammer lever by hand, and re-engage the control trigger. In this case two large multi-spring relief valves are fitted to the up-stream side of the sluice gate to relieve the main of any excess pressure developed during the closing of the sluice. To ensure that the gear is in perfect working order these valves are tripped every week, and they work most satisfactorily.

The term " throttle valve " is generally understood to refer to the simple pivoted disc or butterfly type of valve which is made in many variations of form, for insertion in circular pipes or closed rectangular culverts and occasionally for open channels. Throttle valves are not intended to be absolutely water-tight when closed, though for many practicable purposes they close sufficiently tightly to act as shut-down valves. When positively controlled they are usually operated by worm gear and tooth quadrant, or in larger sizes by screw and lever gear, provision being made for hand or electrical power. For hydraulic operation the valve-lever is usually arranged between two opposed rams, a slide block transmitting the ram motion to the lever. A modern example of an electrically-operated throttle type of valve is furnished by the set of three 6-ft. diameter valves now being installed at the Tata Hydro-Electric Power Supply Company, Bombay Presidency. These valves have cast-steel doors, and cast steel bodies, and will operate under a working pressure of 600 ft. of water. The body is gun-metal lined to provide a good surface for the joint, and the rim of the pivoted door is gun-metal fitted. The valve is arranged to work under " pressure-equilibrium " at all times, both for opening and closing, this being provided for by by-passing across the door when opening and closing other valves on the system before operating the large valve. A 1-h.p. alternating-current motor provides the operating means and drives through worms and worm wheels, and machine-cut gearing—making a total reduction ratio of 3,564 to 1—to a cast steel toothed quadrant on the door spindle. The door swings through an angle of 75 deg., and the total movement occupies 1 minute only. As an emergency precaution hand operation is provided for as a standby. The torque necessary to move these large butterfly valves is very light, as the disc is in equilibrium in all positions ; from the mechanical point of view there seems no reasonable limit to the size in which they could be constructed, and projects are under consideration for manufacturing sizes considerably larger than has yet been attempted.

The throttle or butterfly type of valve is the form most commonly employed for automatic control, as it possesses the two advantages of cheapness and small power needful for operation. An example is furnished by a 49-in. automatic throttle valve recently supplied to a large Tasmanian hydro-electric installation. This valve is intended to cut off the supply in the event of a burst main. The action is very similar to that described

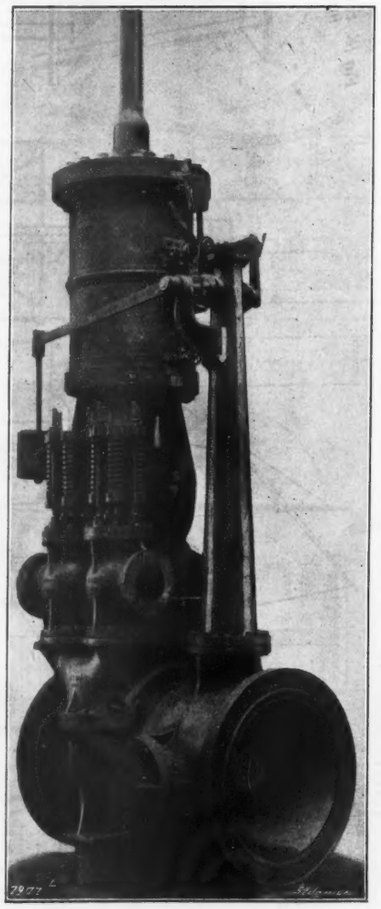


FIG. 11. 39-IN. AUTOMATIC SELF-CLOSING SLUICE-VALVES.

in connection with Fig. 11, with the exception that a deadweight load is released to rotate a pivoted throttle valve in place of the hydraulic cylinder operating a sluice gate.

For pressure reduction purposes, where the throttling faces are retained in close proximity for long periods, the pivoted disc device oscillating on a transverse axis is not the most suitable form, as it does not provide a uniform circumferential aperture. Recourse is made, therefore, to some form of ring valve operating on a longitudinal axis. The type adopted will vary with the conditions to be met, and may be a simple mitre valve or mushroom valve with a single beat or double beat, intended to close watertight when not actually passing liquid, or other annular or piston form intended only as a pressure regulator, and not closing dead-tight. In general such valves are loaded either by spring pressure or deadweight, and their uses and constructions for various liquids and gases are a matter of general knowledge. The problem to be met is usually to reduce from a certain fixed high pressure to a fixed lower pressure, or to give a definite pressure difference between the two sides of the reducing valve, and such requirements are effectively met by the apparatus to which reference has been made. The pressure in a water main, however, is often subject to fluctuation, and it is sometimes necessary to maintain a definite fixed pressure in a branch line regardless of the

* Paper read before the Institution of Mechanical Engineers, at Glasgow, June 27, 1923.

fluctuations in the feeding main. Many valves of this type have been supplied recently, the valve itself being of the balanced double-beat piston type, controlled by a weighted lever, and an auxiliary pressure cylinder. The outlet pressure is determined by the load on the weighted lever, and the pressure cylinder provides the differential effect for the sensitive control of this pressure.

MEASUREMENT OF THE QUANTITY FLOWING.

With many water control schemes it is necessary to measure the quantity flowing, and for this purpose different methods are employed, according to the volume passed and the accuracy desired ; also according to whether the water has a free surface or is under pressure in a pipe or culvert. Then, again, the apparatus will vary according to the type of record required.

A discussion of the many types of small-sized water meters and the improvements which they have undergone recently is a subject in itself, it is only intended therefore to refer to recent developments in apparatus designed to give permanent records for special purposes.

Where the water has a free surface and sufficient fall in level is allowable, a common method is to provide a weir or notch of suitable form with the necessary apparatus for indicating the fluctuation of head over the weir crest. With regard to the character of the measurement of the quantity passing over such weirs, a wide variety of ideas have been recognised in recent years. It is now common to demand continuous and permanent records both of the rate of delivery, and also of the total quantity delivered during any desired interval of time, and it is also frequently necessary to transmit the records to remote distances from the actual point of measurement.

The common hook gauge is useful only for estimating the rate of flow over a weir at any instant by direct observation. When a continuous record is required, suitable float chambers must be constructed, and the necessary rod or cord attachments provided for transmitting the float movements to the recording pen. At the same time clockwork must be provided for actuating the paper diagram on which the permanent record is to be made.

The compound weir and recorder constructed for the Paignton Urban District Council may be cited as an example. Two weirs, 6 ft. wide by 2 ft. deep, are provided for the main body of water, and a small 90-deg. vee notch at a lower level for the passage of compensation water needed for fishery conservation.

Compensation water may be flowing when no water is passing over the big weirs, and it was desired to have a separate record of the main flow and the compensation flow. The apparatus shown in Fig. 12, consisting of two recording drums, and two integrating gears was therefore supplied. Each drum is provided with two pens—one directly operated by a float, indicating the vertical height of the water above the sill of the notch, and the other actuated by a special cam registering the rate of flow. The small drum measures the compensation water up to 1,000,000 gallons per 24 hours, and for greater quantities the large drum, capable of recording up to 56,500,000 gallons per 24 hours, comes into action. Separate integrating gears work in conjunction with each drum and record the total quantity passed on the dials shown in the figure.

Apart from mechanical water meters two simple methods of measuring pipe flow are in use—namely, the Venturi meter, and Pitot tube meter. The former requires the insertion in the pipe line of special tapered tubes, with the latter the Pitot tube can be introduced into a pipe through a plug cock.

The question of great sensitiveness of the apparatus for measuring small differences of pressure plays a very important part both in the design and the accuracy of the Venturi meter and the Pitot meter. In the Venturi meter it has an important bearing on the ratio of throat diameter to pipe diameter, and consequently on the hydraulic loss in the Venturi tube ; while for Pitot tube measurement it is a necessity owing to the small differential pressures produced.

The principle of the Venturi meter is well known, and has been fully dealt with elsewhere ; it is only necessary therefore, to describe the latest developments in the Pitot tube appliances. A modern example of the successful development of the instrument on these lines is provided by the Cole pitometer, originated by Mr. E. S. Cole. Considerable experience has now been obtained with this measuring device, and with the Cole recorder, developed in conjunction with the pitometer, in order to accurately record its indications.

The Cole recording pitometer, Fig. 13, consists of two parts—the pitometer rod meter and the Cole recorder. The pitometer rod meter, which is introduced into a pipe through a 1-in. stop cock consists of a metallic rod, containing two tubes, each terminating in a curved phosphor-bronze orifice, one facing up-stream, and the other down-stream ; the upper end of these tubes are connected with the recorder. The Cole recorder is an extremely sensitive differential pressure recorder. The connecting pipes from the rod meter are taken respectively to the inside and outside of a large multiple diaphragm, and the amount of expansion, which is governed by the rate of flow in the pipe, is transmitted to the recording pen by an extremely sensitive and frictionless mechanism. An integrating motion driven by a separate weight-driven motor operates a total register.

The pitometer causes no loss of head and can be installed on an existing pipe of any size without interruption to the service. Eight of these instruments were installed on eight 36-in. mains for the Glasgow Corporation without shutting a valve.

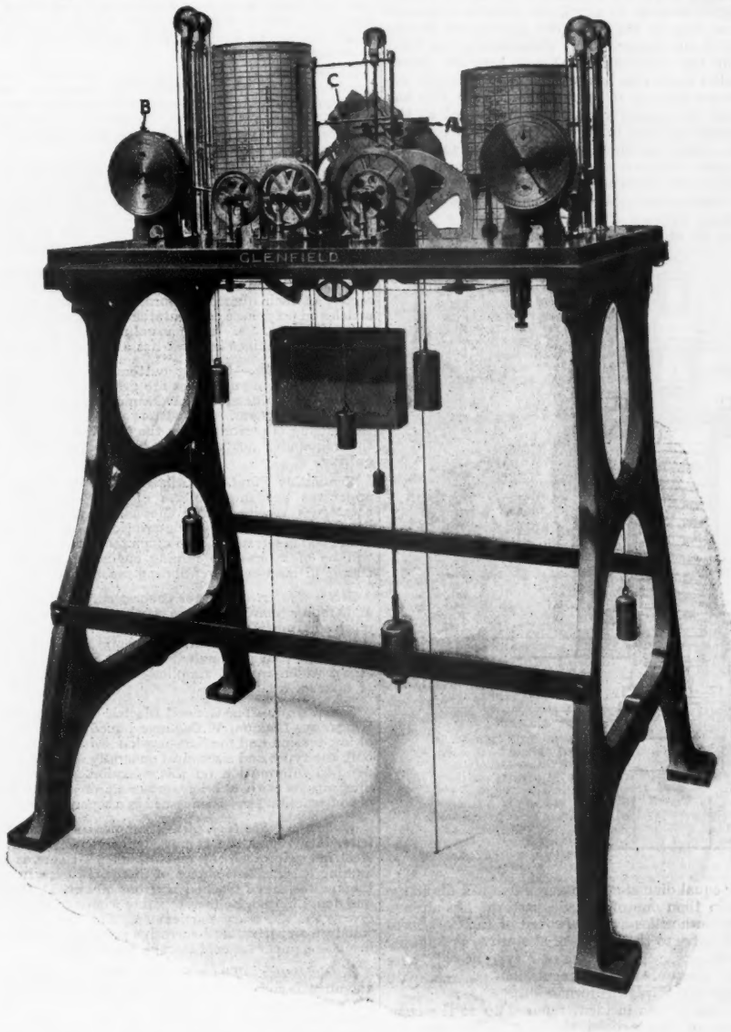


FIG. 12. INTEGRATING DISCHARGE RECORDER (WILLIAMSON).

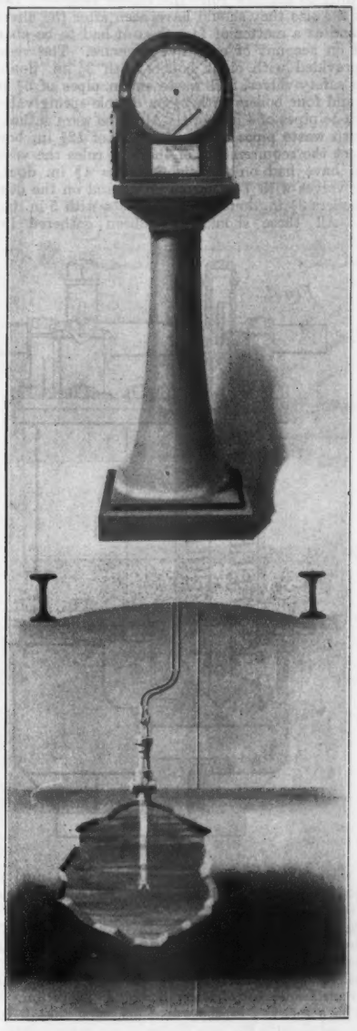


FIG. 13. RECORDING PITOMETER (COLE).

COPENHAGEN PARCEL TRANSPORT.—Under the name "Kobenhavns Pakketransport" (The Copenhagen Parcel Transport) a company has been established in Copenhagen, says the *Danish Foreign Office Journal*, for the collection, transport and distribution of parcels. It has a number of branches in the capital and agencies in all the more important towns of Denmark, and is making a special feature of the clearance and direct distribution of parcels received from abroad.

THE COCKBURN-MacNICOLL HIGH-LIFT SAFETY VALVE.

THE new Board of Trade, Lloyds, British Corporation and other rules base the size of safety valves on boiler heating surface and require one size for coal-fired boilers and another for oil-fired boilers of the same surface. Approximately the area for the valve of a coal-fired boiler is two-thirds that for oil firing. The soundness of this differentiation was practically demonstrated a short while ago when a large liner was converted from coal firing to oil, and it was decided to carry out an accumulation test to see whether the requirements could be met with the original valves. According to the new rules the valves were only two-thirds the size they should have been after the alteration, and as a matter of fact the test had to be abandoned on account of excessive pressure. The vessel was provided with eight boilers with 3⅞ in. double spring safety valves, and waste steam pipes of 5¾ in. bore, and four boilers with 2¾ in. double spring valves and waste pipes of 4 in. bore. All these were gathered into two waste pipes up the funnels, of 12¾ in. bore. To meet the requirements of the new rules the vessel should have had on the eight boilers 4⅝ in. double spring valves with 7-in. waste pipes, and on the other four boilers 3¼ in. double spring valves with 5-in. bore pipes. All these should have been gathered into two waste steam pipes of 15½-in. bore up the funnels. The expense involved in this change would have been, of course, heavy.

A new high-lift safety valve introduced by Messrs. Cockburns, Limited, of the Clydesdale Engineering Works, Cardonald, Glasgow, has been the means of obviating this, and its use has been sanctioned by the Board of Trade, Lloyds, the British Corporation, &c. The characteristics of the valve are such that it has been possible with the new design to approve valves of smaller area than formerly—actually two-thirds the size—owing to the much increased lift obtained with the new pattern, while the waste steam pipe required is 1·1 times the area of the new valve or two-thirds the waste steam pipe of the ordinary valve.

The valve is known as the D. Cockburn-MacNicoll high-lift safety valve, and is illustrated in Figs. 1 and 2 herewith. The feature of the design is that, above the main valve A, a secondary valve D is fitted, below the body C of which is formed a piston head B. On the main valve lifting and pressure rising in the waste pipe the valve D lifts, when this piston enters a cylinder, and being acted upon on the underside by the pressure in the waste pipe, assists in lifting the main valve still further. Thus the waste pipe pressure which usually tends to prevent the safety valve opening its full amount, is utilised to increase the steam passage.

With the ordinary valve care has to be taken to prevent the waste steam pressure rising to such an extent as to interfere seriously with its operation. For this reason the waste steam pipes have to be of very large proportions. Experiments conducted in 1874–75 for a committee of the Institute of Engineers and Shipbuilders in Scotland, formed to urge upon the Board of Trade the adoption of the spring-loaded type of valve in lieu of the deadweight type, which gave endless trouble in a seaway, showed that in action safety valves lifted approximately to the extent of one twenty-fourth of their diameter. In other words the actual area of opening was about one-sixth of the disc area of the valve. In a 3-in. double valve this would mean that the area of escape would be 2¼ sq. in., so that a 1⅛ in. hole in the boiler would pass all the steam. If 100 per cent. increase be allowed for pipe resistance, a waste steam pipe 2¼ in. in diameter would meet the situation. The size required to prevent the waste pipe pressure rising so as to affect the working of the valve is actually 4¼ in. The same set of experiments referred to above clearly indicated that the quantity of steam discharged from a higher pressure to any lower pressure remained constant so long as the lower did not exceed 58 per cent. that of the higher. This phenomenon has been utilised in the Cockburn-MacNicoll high-lift valve, and a smaller waste pipe has been adopted to secure the back pressure required to operate the valve. This has not affected the quantity of steam discharged as the back pressure adopted is no more than 30 lb., which, on 200 lb. boiler pressure, in no way approaches the limiting value of 58 per cent. Messrs. Cockburn have, in fact, conducted tests which have been accepted by Lloyds, showing that this value could be as high as 60 per cent. without affecting the discharge. With the higher lift of course a smaller valve is allowable, while, for equal diameters, the new valve will discharge much more than one of the old pattern. As already stated the authorities have approved of the Cockburn-MacNicoll valve to the extent of accepting, as fulfilling all requirements, valves of the new type of only two-thirds the area of the old regulation pattern, with waste pipes two-thirds the former size.

Fig. 1.

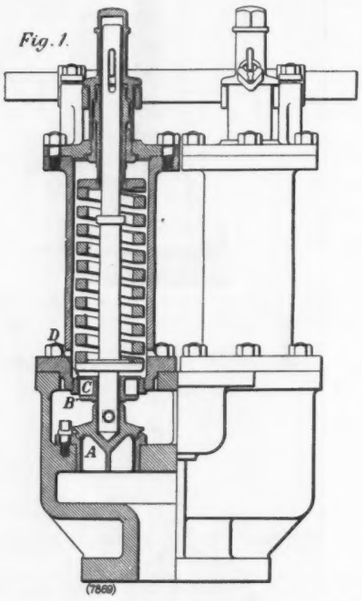
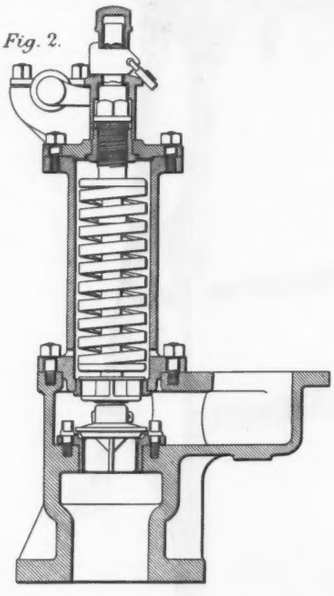


Fig. 2.



In the case of the incident referred to at the commencement of this article, the new valve met the situation and obviated heavy expenditure. The existing valves of the ordinary type were altered to the new type of high-lift valve without a boiler or pipe joint being broken. The spring cases with spindles were taken off, the secondary valves fitted and the cases bored to suit, and the whole assembled again in a very short time. The result was very satisfactory, and in a subsequent accumulation test a very low accumulation pressure—about 2 per cent. only—was recorded. The saving in expense will be obvious. Instead of having to fit completely new valves of larger size and much larger waste pipes, the expense was restricted to the conversion of the old valves to the high-lift pattern of the same diameter. We understand that as a result this valve is being taken up by a number of shipping companies for new work and in cases similar to the above of converting from coal to oil.

THE INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—A meeting of the Institution is to be held in the East Midland District, Nottingham, on Friday and Saturday, the 27th and 28th inst. A number of papers will be read and discussed and visits paid to places of interest. Applications are to be sent to Mr. Thos. Wood, Hon. District Secretary, City Engineer's Office, Town Hall, Leicester.

CATALOGUES.

Lubricants.—A concentrate for addition to various oils to increase lubricating efficiency is described in a catalogue received from Messrs. Henry Wells Oil Company, Salford, Manchester, who also give some useful general information on the subject.

Coal Conveyor.—A pneumatic coal conveyor for raising coal from barges or dumps, and screening and discharging it to overhead bunkers, is described by Messrs. Henry Simon, Limited, 20, Mount-street, Manchester. The illustrations are of a plant installed by the firm at a London power station.

Laundry Machinery.—Machines for washing, centrifugal extracting, roll ironing and flat ironing are the principal items in an excellent catalogue received from Messrs. D. and J. Tullis, Clydebank, who show several improvements in mechanical efficiency and in general convenience of operation.

Electro-Medical Apparatus.—Leaf catalogues of high frequency apparatus for violet ray treatment and of films for dental radiography have been received from Messrs. Watson and Sons, Limited, Parker House, Kingsway, London, W.C. Clear explanations of the uses of the apparatus are given.

Induction Motors.—The English Electric Company, Limited, Kingsway, London, W.C., have sent us a new catalogue dealing specially with induction motors which they are making in standard sizes, ranging from 100 h.p. up to the largest likely to be required. All the principal parts are illustrated separately and fully described.

Electrical Machines.—The A.C.E.C. Company of Belgium (London office, 56, Victoria-street, S.W. 1) send a copy of their quarterly journal, in French, containing articles on polyphase commutator motors, mine signalling, cranes, pumps, &c. Their usual monthly list of motors and other machines in stock has also been received.

Screwing Dies.—Chasing cutters for use in the die-heads of screwing machines are described in a catalogue received from Messrs. S. A. Daniell, Limited, Edward-street, Birmingham. The cutters are of the type in which the cutting is performed by the first few threads, while the remainder act as guides and burnishers without cutting.

Ventilating Plant.—Ventilating fans and air washing apparatus are the subjects of two very interesting catalogues received from Messrs. Davidson and Co., Limited, Belfast. The descriptions are exhaustive, with good illustrations, and much technical matter which will be of interest to mining engineers and others in charge of large-scale ventilating machinery.

Motor Converter.—Motor generators, rotary converters and motor converters are compared in a catalogue received from Messrs. Bruce Peebles and Co., Limited, Edinburgh, who explain the theory and operation of the motor converter and discuss its mechanical advantages, which include simplicity of operation, low cost of upkeep, &c.

Switch Gear.—The General Electric Company, Limited, Kingsway, London, W.C., have issued a new catalogue of low-tension and medium-tension switch gear, showing only the types and sizes most generally in use and giving detailed information on this selection. A few general illustrations with a brief statement of special features of construction have been issued in a separate publication.

Waterproof Sheeting, &c.—Samples of a number of felts, bituminous sheets and damp courses, some with steel net reinforcement and others with canvas backs, making an excellent choice of materials, each in several thicknesses, have reached us from Messrs. D. Anderson and Son, Limited, Belfast, together with a small catalogue giving the necessary particulars. The firm also makes wood preservative, anti-corrosive paint and an odourless insulating paper for cold storage construction.

Special Steels.—The special steels made for motor car and aircraft construction are coming into use for machine parts and general construction, and have considerable advantages in certain applications. A catalogue received from Messrs. Edgar Allen and Co., Limited, Sheffield, gives exhaustive and well-arranged information relating to the use of these steels and the tests and heat treatment required. The catalogue forms a concise and useful reference work.

Instruments for Power Plants.—Measuring instruments for the boiler house and engine room are the subject of a special catalogue issued by the Cambridge and Paul Instrument Company, Limited, 45, Grosvenor-place, London, S.W. 1. The instruments include CO_2 apparatus, thermometers, pyrometers, stator and rotor temperature measuring apparatus and various gauges, recorders, counters, &c. These are all sufficiently illustrated and described to make the publication one likely to prove of service.

Steel Products.—Steel worked into shape for machinery parts, boilers, rails and general constructional work, provides most of the matter for a handsomely-printed catalogue of over 100 quarto pages, issued by Messrs. William Beardmore and Co., Limited, 183, West George-street, Glasgow. Other products dealt with range from heavy castings and forgings for shipbuilding, engine construction, electrical machinery, presses, &c., to small parts such as blanks for pinions. Heavy work, and standardised parts such as railway axles, are supplied finished or in the rough, and there is the widest range of ordinary and special steel for use in the machine shop. Some interesting views of the works and of ships built and engined by the firm are included in the catalogue.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACTS OF 1907 AND 1919.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the communicators are given in italics.

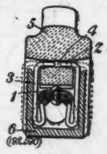
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 1s.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

ELECTRICAL APPARATUS.

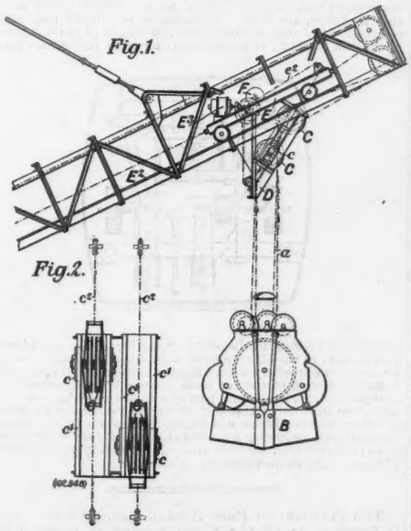
192,590. A. C. Smith, Shepherd's Bush. Spring Contacts. (14 *Figs.*) January 19, 1922.—The invention has reference to the spring contacts of electric switches, fuse holders and the like. A spring contact, according to the invention, comprises a metal strip bent or pressed towards its desired final shape and with its end portions adapted to engage, or be engaged by, the holder by the application of pressure to the outer limbs or members of the contact which are thereby caused to approach one another in parallel planes. The spring contact comprises



a strip of metal bent or pressed into "W" shape with the central member 1 of the figure somewhat flattened, and the free ends 2 of the outer members 3, which are parallel to one another, bent or turned over in line and extending towards one another. The bent or pressed over ends 2 of the members 3 are passed into a slot 4 formed in the holder 5, and are caused to approach one another and contact or come in close proximity by pressure applied to the outer members 3, which are thereby caused to approach one another in parallel planes and further deform the central member 1. (*Sealed.*)

LIFTING AND HAULING APPLIANCES.

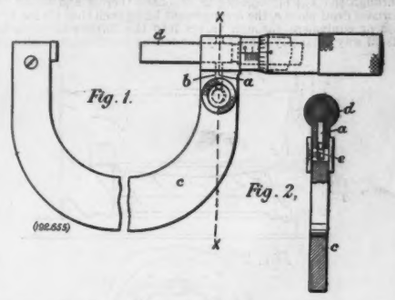
192,546. The Wellman-Smith-Owen Engineering Corporation, Limited, London, and F. G. Smith, London. Cranes. (2 *Figs.*) December 6, 1921.—The invention relates to cranes wherein a grab is used for carrying material from place to place. The pulleys C over which the fall or loops *a* of the hoisting and lowering ropes or chains pass and are attached at different points to the grab B, are each mounted in bearings in a carrier *c*, which can slide between guides c^1 on a structure D attached to the underside of the trolley E by which the grab B is carried along the runway E^2, in one direction to the position at which the grab is to take its load and in the other direction to the position whereat



it is to deliver its load. Each carrier *c* can be moved longitudinally between its guides c^1 by a chain c^2 attached to one end of the carrier and led over and under sprocket wheels mounted on the trolley E and structure D and then attached to the other end of the carrier. An electric motor E^3, carried upon the trolley E, transmits rotary motion through toothed gearing F, to the sprocket wheels, whereby movement of the carriers *c* in opposite directions is effected. The guides c^1 are inclined so that the ropes or chains *a* from the pulleys C are kept of, or about, the same length between each pulley and the corresponding point of attachment to the grab B. (*Sealed.*)

MACHINE AND OTHER TOOLS, SHAFTING, &c.

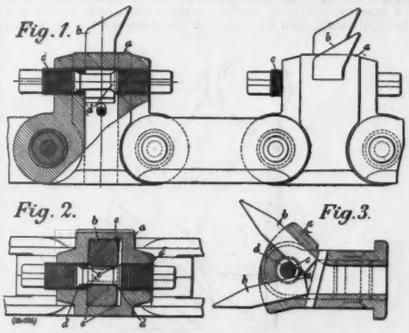
192,655. Ambrose Shardlow and Co., Limited, Sheffield, and W. Borringham, Sheffield. Micrometer Gauges. (3 *Figs.*) May 6, 1922.—The invention refers particularly to external gauges and provides a simple and ready means for locking the adjusting spindle. A device for locking the spindle of an external micrometer gauge made in accordance with the invention comprises a pin or tappet *a* disposed in a slot *b* in the frame *c* of the micrometer, one end of the pin or tappet being adapted



to engage the micrometer spindle *d*; a cam or eccentric *e* engages the other end of the pin or tappet *a*, and a plate flange or plate flanges on or secured to the cam or eccentric *e* is or are adapted to be rotated by the operator to move the tappet or pin into or out of engagement with the spindle *d*. (*Sealed.*)

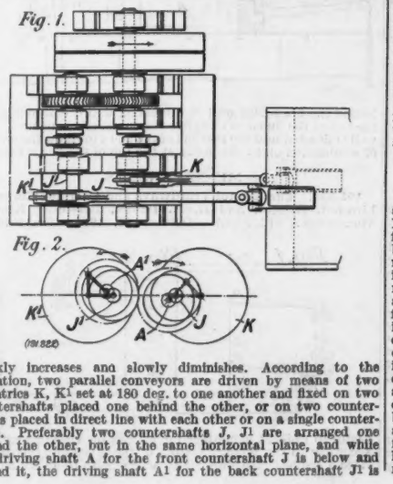
MINING, METALLURGY AND METAL-WORKING.

191,486. M. B. Wild, Nechells, Birmingham, W. H. Dunn, Nechells, Birmingham, and M. B. Wild and Co., Limited, Nechells, Birmingham. Coal-Cutting Machines. (6 *Figs.*) October 14, 1921.—The invention relates to coal-cutting machines of the chain type, and has for its object to provide improved means for securing the detachable tools within the tool-boxes or holders forming part of the chain. The tool-box *a* is formed with sockets for the reception of the shanks of cutting tools *b* and screwed transverse apertures are formed in opposite ends of the box. The box is provided with a long screwed pin *c*, and this is located to pass between the tool shanks. The pin is screwed at both ends, the central portion being reduced in diameter and formed with tapered shoulders *d*. In use, the pin



is brought to a central position relatively to the box, and the tools are then inserted into the box past the pin until a recess *e* in the adjacent side or edge of each tool comes opposite the pin. The tools are secured by screwing the pin in the appropriate direction for bringing one of the tapered shoulders *d* into engagement with the recesses in the tools. By this action the tool is held against endwise movement, and pressure is exerted on each tool in two directions at right angles, thereby ensuring rigid fastening of the tools within the box. When it is required to reverse the tools, the pin is returned to the central position, and after the tools, have been re-inserted the pin is moved in the opposite direction for re-engaging the tools, the shoulder *d* then engaging other recesses *e* in the tools. (*Sealed.*)

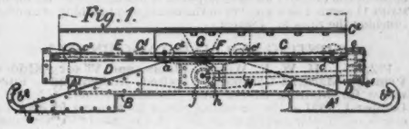
191,822. Head, Wrightson and Co., Limited, Thornaby-on-Tees, R. S. Benson, Thornaby-on-Tees, and H. Clark, London. Screening and Washing Coal. (6 *Figs.*) October 17, 1921.—The invention relates to mechanism of the type in which a reciprocating movement is imparted to a conveyor or screen, and the coal is moved along the conveyor by causing the conveyor to move forward with a speed which slowly increases and quickly diminishes, and then backward with a speed which

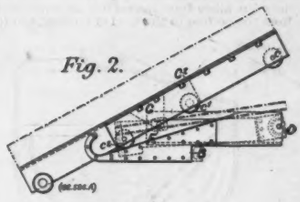


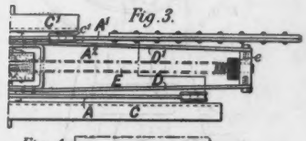
quickly increases and slowly diminishes. According to the invention, two parallel conveyors are driven by means of two eccentrics K, K^1 set at 180 deg. to one another and fixed on two countershafts placed one behind the other, or on two countershafts placed in direct line with each other or on a single countershaft. Preferably two countershafts J, J^1 are arranged one behind the other, but in the same horizontal plane, and while the driving shaft A for the front countershaft J is below and behind it, the driving shaft A^1 for the back countershaft J^1 is behind and above it, the two driving shafts being geared together so that they rotate in opposite directions. By this arrangement the material in both conveyors is propelled in the same direction, although the conveyors move simultaneously in opposite directions. (*Sealed.*)

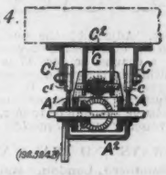
MOTOR ROAD VEHICLES.

192,524. W. H. Simmons, Wolverhampton. Tipping Wagons. (4 *Figs.*) November 16, 1921.—The invention relates to tipping gear for motor lorries. A, A^1 are a pair of transverse plates forming rails. They are connected across by a web A^2 so as to form a channel which is secured upon the chassis frame B. The plate A has its upper edge running horizontally from the right-hand end up to the point *a*, and from thence it slopes down to the point *b*, beyond which a curl b^2 is provided to act as a stop. The plate A^1 is shaped in like manner but the reverse way round. C, C^1 are two angle irons bolted transversely across the underside of the body, a cover plate C^2 being interposed. The angle iron C extends to the right-hand side of the body and overlaps the angle iron C^1 somewhat, but is not extended entirely to the left-hand side. The angle iron C^1 is arranged in a similar manner at the other side of the appliance and extends to the left-hand side. The angle iron C has pivoted thereto two wheels *c* and c^2 both adapted to run on the top edge of the plate A; and the angle iron C^1 has pivoted to it two wheels c^1, c^3 both adapted to run along the top edge of the plate A^1. D, D are two frame plates, each slightly bowed and connected at their ends by end plates in which is journalled along transverse screw E, upon which is screwed a nut F having trunnions journalled in a bracket G bolted to the under surface of the body, the plate C^2 intervening. The screw E has a spur pinion *e*







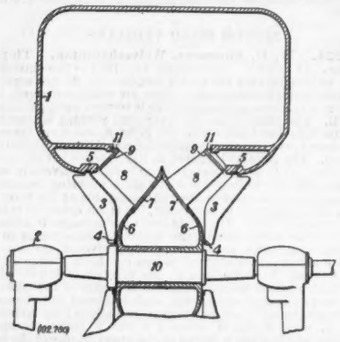


rigidly mounted at its right hand end, and this spur pinion meshes with a spur pinion e^1 rigidly mounted on a shaft H. On the inner end of the shaft H is a bevel wheel h engaging with a bevel wheel *j* which is rigid with a shaft running along the centre of the vehicle and serving both as the pivot centre about which the frame plates D, D^1 may rock in relation to the plates A, A^1 and as means whereby similar gear at the front of the vehicle is operated, this shaft passing through bearings in all the plates D, D^1. When it is desired to tip the body, say, to the left as shown in Fig. 2, this shaft may be turned by means of a key from the rear in an anti-clockwise direction, or any of the other shafts may be turned if desired. This causes the screw E of each apparatus to rotate in a direction to force the nut F along the screw, the latter being prevented from moving endwise in relation to the pivoted frame plates D, D^1. The nut F being trunnioned to the bracket G, draws it along, impelling the body towards the left, as shown in Fig. 2. The angle irons C, C^1 with the wheels move with the body, the wheel c^2 running down the slope of the plate A, while the wheel *c* keeps along the horizontal. The wheel c^3 immediately runs over the end of the plate A^1 and the wheel c^1 lifts up from the plate A. The body may be tipped past the position shown in Fig. 2 until the wheel c^2 rests in the curled end of the plate A. The function of the wheels *c* and c^3 is merely to support the side edges of the body against rolling when in transit. (*Sealed.*)

PUMPS.

192,760. James Howden and Co., Limited, Glasgow, and W. H. Howden, Glasgow. Centrifugal Fans. (1 *Fig.*) November 7, 1921.—The invention consists broadly in a centrifugal fan the impeller of which comprises a hollow sectional boss between elements of which is or are clamped a blade-carrying ring or rings, the blades standing out from the ring or rings at an inclination to the axis of rotation, the boss not being subjected to radial stresses. The fan shown comprises a volute casing 1 and an impeller mounted for rotation therein. The volute casing is formed as a rigid casting with two bearings 2. Fitted to the inlet openings are substantially radially disposed guide blades 3 of sheet metal welded on to inner and outer rings 4, 5, of which each outer ring 5 is accommodated in a groove in the casing 1. The impeller comprises a hollow two-part boss 6 between the halves of which are clamped symmetrical rings 7 to which the blades 8 are attached, the blades standing out from the rings 7 at an inclination to the axis of rotation. The blades 8 are further united by outer rings 9. The boss 6 with rings 7 makes up a figure of approximately lozenge shape in cross-section, the boss 6 being fixed on the impeller shaft 10. The boss comprises symmetrical halves and is constructed as light as possible consistent with the requirements of strength and rigidity. No radial stresses are

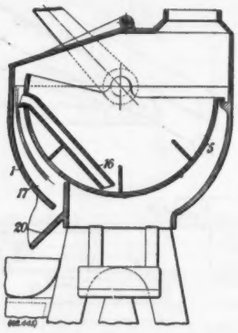
transmitted to the boss. The rings 7, 9 are inclined to the axis of rotation. The blades 8 may be flanged and fixed to the rings 7 by means of separate rivets, or projections on the blades



may be fitted and riveted into slots cut in the rings. The clearance between the casing 1 and the impeller is diminished by means of strips 11 secured into grooves in the casing and touching or almost touching the rings 9. (*Sealed.*)

PRINTING AND ALLIED MACHINERY.

192,445. H. W. V. Wilson, Meols, and Victory-Kidder Printing Machine Company, Limited, Birkenhead. Furnaces for Melting Stereo and Similar Metals. (2 *Figs.*) October 1, 1921.—The invention relates to furnaces for melting stereo and similar metals which melt at a relatively low temperature. According to the invention, the metal poured from the pot or container 5 is taken from the bottom by employing a duct 16 leading from the bottom to the level of pouring, the top of which



is in the form of a spout. Adjacent to the pouring spout 16 and the front of the pot 5, in the outer casing or vessel 1 in which it is disposed and works, a channel or duct 17 is formed, in which the spout moves in tilting the pot, and down which the metal runs to the discharge lip or runner 20 below. By this means the metal is prevented from spluttering sidewise, and is conducted as desired in a body to the discharge aperture or runner, which is near the bottom of the outer vessel or case. (*Sealed.*)

RAILWAYS AND TRAMWAYS.

192,446. C. P. Sandberg, London. Railway and Tramway Rails. (3 *Figs.*) October 6, 1921.—The improvement in the manufacture of railway and tramway rails made of steels having normally pearlitic structure, consists in applying a gentle cooling agent to the portions of the hot rail which are of heavier section, in such a manner that these portions shall arrive at and pass through the range of temperature 450 deg. to 300 deg. C. at approximately the same time as the portions of lighter section. The cooling agent is preferably a blast of air or air and an atomised fluid. The most convenient method of distributing the cooling fluid to the various parts of the section is by projecting the main bulk of it on to the surface of the head, but, instead of letting it immediately escape, to confine and direct it by a series of guide plates so that it subsequently passes over the surfaces of the parts of lighter section as indicated in diagrammatic cross-section in

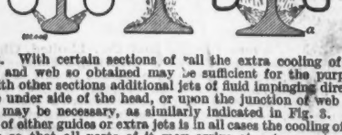
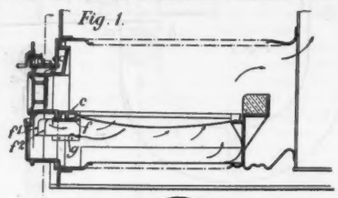
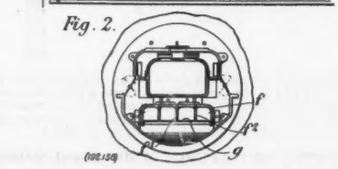


Fig. 2. With certain sections of rail the extra cooling of the flange and web so obtained may be sufficient for the purpose, but with other sections additional jets of fluid impinging directly on the under side of the head, or upon the junction of web and flange may be necessary, as similarly indicated in Fig. 3. The object of either guides or extra jets is in all cases the cooling of the section so that all parts of it may arrive at a temperature of about 450 deg. C., and cool down from this temperature to about 300 deg. C. at the same rate, this result being judged partly by temperature measurements, either by eye or pyrometer, and partly by the tendency of the whole rail to camber during cooling from about 450 deg. to 300 deg. C. In each of the figures of the drawings *a* represents a railway rail and *b* an air pipe or chamber delivering blasts of air. In Fig. 2 *c* represents guide plates. (*Sealed.*)

STEAM ENGINES, BOILERS, EVAPORATORS, &c.

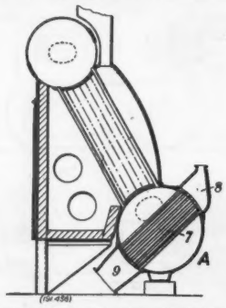
192,156. J. Reid, London. Furnaces. (4 *Figs.*) October 26, 1921.—The object of the invention is to provide means for directing air to the front part of the grate which can be readily fitted in existing furnaces provided with hollow forced draught fronts. The means comprise a casting *f* with longitudinal division plates f^1, f^2 and floor plate *g* and adapted to be bolted into an existing hollow furnace front so as to extend across the front and through the ash pit opening in the back thereof and under the furnace dead plate *c*, the arrangement being such that air fed by a fan or equivalent through valves into the furnace front in the usual way is largely caught by the means described and directed





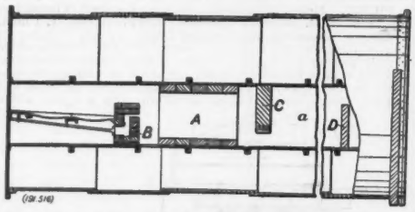
thereby through the front part of the furnace grate, whilst the remainder of the grate receives air from the ash pit, these supplies of air giving an adequate and approximately correct amount of air for proper combustion; the air passing to the grate through the ash pit may be supplied by the fan or equivalent, or may be air admitted thereto from the stokehold, the chimney or funnel draught being sufficient to draw the air through the grate. (*Accepted February 7, 1923.*)

191,456. Scotts' Shipbuilding and Engineering Company, Limited, Greenock, and A. Rennie, Greenock. Steam Generators. (3 *Figs.*) October 11, 1921.—According to the invention, steam generators of the water-tube type are constructed or adapted to be heated either by the combustion of solid, liquid or gaseous fuel or by the hot exhaust gases from one or more internal-combustion engines, and are characterised by a water



drum A having a nest of tubes 7 communicating, at opposite ends, with chambers 8 and 9. In associating the generator with one or more internal-combustion engines, the chamber 8 is connected with the exhaust pipe of the internal-combustion engine, and a final exhaust pipe is connected with the chamber 9 and led separately to the uptake or funnel or is otherwise conveniently disposed. (*Sealed.*)

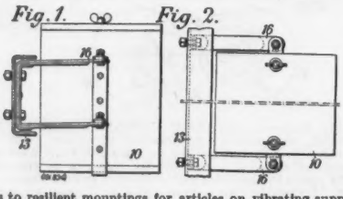
191,516. A. W. Crowther, Barcelona, Spain. Steam Boilers. (6 *Figs.*) October 29, 1921.—This invention relates to steam boilers of the Lancashire, Cornish or similar type. The invention consists in the general arrangement of the boiler comprising an additional combustion chamber A of tubular shape



behind the fire bridge wall B, a firebrick wall C descending from the top of the flue *a* to complete the combustion chamber, and a wall D situated near the rear end of the flue *a* to throw the products of combustion on to the plates at the top of the flue. (*Sealed.*)

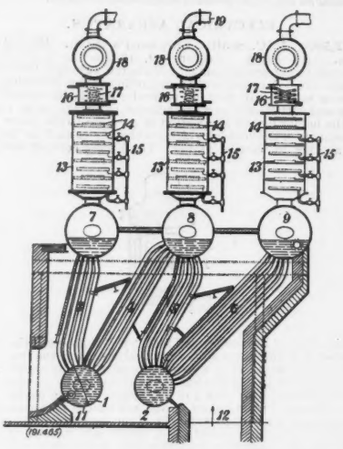
MISCELLANEOUS.

191,834. The Bristol Tramways and Carriage Company, Limited, Bristol, and B. A. Payne, Bristol. Resilient Mountings. (2 *Figs.*) October 20, 1921.—The invention



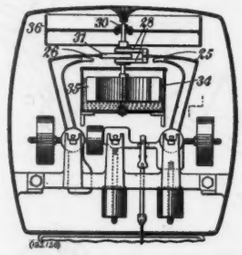
relates to resilient mountings for articles on vibrating supports. According to the primary feature of the invention, there is provided a resilient mounting for an article (such as an accumulator case) on a vehicle comprising a pair of plate springs 16 connecting the article 10 and support 13, the points of attachment of which springs to the article are separated from one another. The plate springs are situated one above the other and operate in unison as a cantilever to permit relative movement in a substantially vertical direction between the said parts, but to prevent other relative movement. Conveniently the plate springs 16 together constitute a unit that is of U-shape, and is placed with its sides lying horizontal and one above the other, the base of the U and the free ends of both of the sides thereof forming the points of connection of the spring to the support 13 and to the article 10, respectively. (*Sealed.*)

191,465. The Stirling Boiler Company, Limited, Westminster, London, and W. W. Watt, Golders Green. Petroleum Preheaters and Fractionating Stills. (1 *Fig.*) October 12, 1921.—The invention relates to petroleum preheaters and fractionating stills. The preheater and fractionating still is constituted by a five drum Stirling boiler of which the upper and lower drums constitute upper and lower vessels connected by tubes. The lower drums 1, 2 are connected by the banks 3, 4, 5, 6 with the upper drums 7, 8 and 9, the lower drum 1 to which



is connected the petroleum inlet pipe being divided by a partition 11 into two compartments. The inlet for the heating medium in the form of waste heat is at 12. Each of the upper drums is surmounted by a combined dephlegmator, scrubber and vapour drum. Each dephlegmator 13 is of the usual type fitted with trays 14, and run down pipes 15. Each scrubber 16 is fitted with coils 17, through which cold water or oil may be passed. Each vapour drum 18 has a connector 19 leading to a condenser. (*Sealed.*)

193,156. W. and T. Avery, Limited, Birmingham, and C. McG. Sykes, Birmingham. Automatic Weight-Indicating Mechanism. (3 *Figs.*) November 19, 1921.—The invention consists of improvements connected with automatic weight-indicating mechanism of the kind which embodies a drum 36 mounted on a vertical spindle 30 and adapted to rotate in a horizontal plane, characterised by the provision of a float 35 on the spindle 30, the float being mounted in a liquid containing receptacle 34 in such a manner that the weight of the indicating mechanism is wholly or substantially offset by the upward force



imparted to the float by the liquid. A further feature of the invention consists in rotating the drum indicator 36 in either direction by means of oppositely-wound flexible ribbons 28, 31 (preferably metallic), the outer ends of these ribbons being mounted upon cam faces 25, 26, which form part of a duplex pendulum weighing gear, the load being transmitted to the pendulums by means of other flexible ribbons which have connection to the bottom work of the scale in such a manner that any motion of the pendulums is transmitted through aforesaid oppositely-wound flexible ribbons to the drum indicator. (*Sealed.*)

THE FIAT GRAND PRIX RACING CAR.—An endeavour is being made by the Fiat Company to improve the efficiency of their engine by better scavenging of the cylinders. This is being done by forcing the explosive mixture into the cylinder under pressure. A rotary compressor is fitted at the front end of the engine, driven directly off the crankshaft, and has a housing which forms the support for the radiator. The compressed air is delivered to the carburettor through a passage cast with the base chamber. Unlike some other superchargers used on racing engines the Fiat compressor is always in operation and runs at engine speed, but automatic valves are provided to allow the excess air to escape when running at a reduced number of revolutions. In the hill climb up the Faucille pass, a distance of 6½ miles, and with gradients of 1 in 10, the Fiat in the 1,500 c.c. class made the fastest time.